1952

NEW ZEALAND

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(TWENTY-SIXTH ANNUAL REPORT OF THE)

Presented to the House of Representatives by Leave

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MINISTER'S STATEMENT

THE report of the Department of Scientific and Industrial Research for the financial year ended 31 March 1952 is presented herewith.

The Department has been called upon to meet the increasing needs of State Departments and industry for scientific services. Research of considerable economic value to the State and to New Zealand industries has been accomplished, and the findings resulting therefrom publicized in order that they may be implemented and put in use for the national welfare. A live interest exists in industrial circles for the promotion of Research Associations, as those already established have shown progressively their great advantages to manufacturers. From those Branches of the Department engaged in scientific work for agriculture, a large amount of new knowledge has emerged that in application should benefit greatly the farming industry, which has continued to display a keen realization of the value of new knowledge.

The Department's activities have continued to help the assessment and exploitation of the Dominion's natural resources of soil, minerals, water, geothermal steam, and timber, and much progress has been made in most of these fields.

Close association has been maintained with scientific work done overseas, to the great advantage of local effort and development.

The maintenance of scientific services and a research organization of the highest possible standard to deal with State and industrial problems is widely recognized as a feature of good government. The Department has continued to handle successfully the wide range of problems arising in the Dominion and which are referred to it.

R. M. ALGIE,
Minister in Charge of the
Department of Scientific and Industrial Research.

SECRETARY'S REPORT

The Hon. R. M. Algie, Minister in Charge of the Department of Scientific and Industrial Research.

I have the honour to submit herewith the annual report of the Department for the year ending 31 March 1952.

The capacity of the Department to deal with the steadily increasing demands for scientific service and research from other State Departments and from industry has been fully taxed. An increase in such demands is accepted as a sign of normal progress in a country that depends so much upon science, and whose industries are affected to an increasing extent each year by advances in scientific development overseas. Chemical methods for the control of plant and animal diseases have, as the result of research in the United Kingdom and United States of America, progressed at a remarkable rate in quite recent years. The advent to New Zealand of these new materials of very complicated chemical composition necessitates additional scientific guidance locally. The same circumstances prevail in a number of other fields where the impact of overseas scientific development is felt in the Dominion and influences its industries.

It is the responsibility of the Department (*a*) to provide scientific service for all Government Departments and industries, (*b*) to maintain certain international scientific services as a part of New Zealand's obligations, and (*c*) to undertake research into matters affecting the natural resources of the Dominion.

Government Departments during the year have made increased demands on the services they need for the efficient administration of their activities, and there is a steadily growing realization of the economic value and worth of the guidance provided by the Dominion Laboratory, the Dominion Physical Laboratory, the Geological Survey, and the Soil Bureau, on the wide range of problems that State Departments are faced with today.

In the increasing complexity of these problems—many of which cannot be dealt with by any one scientist but require team effort and perhaps the combined knowledge of chemists, physicists, geologists, and biologists for their solution—the advantages of a departmental organization embracing all these scientific disciplines is obvious. Team work in the Department's activities has been showing its value to a greater degree each year.

It was necessary, in consequence of restriction in the vote, to curtail activities in many branches during the year, and, despite the demands received for additional assistance from some quarters, no expansion of activities was possible. Such a state of affairs cannot persist for long in a scientific and research organization without causing very serious effects which the future will experience much difficulty in remedying. The tide of scientific advance is affecting every activity of our national life, and a Department of Scientific and Industrial Research that ceases to be dynamic soon atrophies and ceases to be of much real value. Recruitment of scientific staff during the year was exceptionally low, and losses of experienced and proved scientific staff was high. The position was retrieved to some extent by the return from overseas of men who had completed advanced studies in various fields. On account of the impression and far-reaching effects of a reduction in the vote on the attitude of the staff, and also of the fact that the salaries of senior staff of proved ability remain at lower levels than those paid in University colleges in New Zealand and in scientific organizations overseas, the Department seems likely to lose potential leaders from its service. This is a loss that New Zealand—a country so dependent for its welfare on the development of natural resources, a field that demands scientific help of the highest quality—cannot afford without serious detriment to its future prosperity.

Both farmers and manufacturers continue to show great readiness to apply the results of research and to maintain a steady pressure for further progress. This is very encouraging, but makes it necessary for the Department to ensure that its scientific staff maintains itself thoroughly up to date in all new knowledge and has those qualities of initiative and enterprise essential to provide leadership and inspire the confidence both of farmers and manufacturers. Such cannot be done if the funds for research remain static for very long.

Accommodation difficulties are still very real in many branches of the Department and lead to inefficiency. In Wellington some improvement is in sight with pending transfers of sections of the Dominion Laboratory and the Research Associations to Gracefield, but this problem will not be solved until new buildings for the Dominion Laboratory are erected at Gracefield and the Geological Survey takes over the vacant accommodation resulting from this transfer. Conditions remain most congested in the Botany Division, the Plant Diseases Division, and the Fruit Research Station, and little relief seems likely while the present building difficulties continue.

The overseas scientific liaison officers, the staffs of research organizations in other Commonwealth countries and in the United States of America, and the Commonwealth Agricultural Bureaux have continued to supply very valuable information and guidance in a number of projects, so that work in the Department has had the advantage of being kept thoroughly up to date, and the unnecessary duplication of effort has been avoided.

During the year, the Department lost the services of five of its senior officers. Mr. E. Bruce Levy, Director of the Grasslands Division, retired at the conclusion of a long period of fine service in the Departments of Agriculture and Scientific and Industrial Research, his achievements in the promotion of grassland farming being of outstanding economic and scientific value to the Dominion. Mr. M. Ongley, Director of the Geological Survey, retired after a career of conspicuous service and work on many aspects of New Zealand geology. The retirement of Dr. J. Marwick, Senior Paleontologist, Geological Survey, came after a long period of distinguished work concerned with fossils. Dr. Marwick's work related both to the part fossils play in the interpretation of geological formations (such as is required in the search for oil), and the fundamental knowledge (to which he contributed extensively) of New Zealand fossil groups. Dr. H. J. Finlay died early in the year and a tribute to his work appears in the report of Geological Survey. Dr. O. H. Frankel resigned to accept appointment as Chief of the Division of Plant Industry, C.S.I.R.O., Canberra. Dr. Frankel during his years of service in the Department was responsible for the scientific work that produced pedigree lines of wheat yielding flour of very high quality and which have largely supplanted the varieties previously grown.

Some reference should be made to the achievements of the year. Geological surveys of the main coalfields, Nightcaps, Ohai, Kaitangata, and Greymouth, now completed, have provided detailed knowledge of their resources; of particular interest are the very extensive coal measures found in the Kaitangata field. Surveys in those portions of North Auckland where deficiencies in water-supplies for farm purposes exist have shown the rock formations where good and bad prospects for securing supplies actually occur.

Geological and geophysical investigations, associated with drilling operations, located a definitely hot area at Wairakei of sufficient promise to merit the inauguration of a development programme to prove the existence there of a steam potential capable of generating 20,000 kW. Chemical investigations of the steam indicate that it has a very low content of gas and an absence of corrosive properties. Drilling to depth in pumice formation, where temperatures

and pressures increase markedly with depth, presents some most unusual problems, all of which have been overcome by the originality and initiative of a combined team. The measurement of temperatures at depth in bores has been achieved by the design and construction of a geothermograph, which has proved most efficient in operation.

Research on the extremely complex problem of spontaneous combustion in wool cargoes has to date indicated that fires are confined to "pie" wools—*i.e.*, those wools removed from skins by a bacterial process. These often contain, because of imperfect scouring, a high percentage of body fat (as distinct from wool grease, which in unscoured fleeces is harmless), and this is a potential source of danger that can be overcome at present only by very thorough scouring of pie wool. The solution of this problem will have an annual value of many thousands of pounds, since these particular losses through fires in wool cargoes can now be avoided.

The occurrence of branched chain acids in butterfat, which were discovered last year, represent a marked advance in fundamental knowledge. Investigations of the nutritional value of these new compounds are being undertaken, because their economic importance may be considerable.

The discovery of the causal agents of the dread yellow-leaf disease of phormium, reported last year, has been followed up, and now it has been shown that the insect vector of this virus disease may be killed in all its stages by flooding phormium areas to a depth of 2 ft. to 3 ft. for a fourteen-day period. Yellow-leaf disease accounted largely for the halving in production of flax fibre that has occurred since 1938, and it constituted the most serious menace to the future of the whole industry. The value of this scientific advance in its application would be most difficult to assess, since the saving of almost the whole industry is involved.

The establishment of a system for the certification of plant hormone sprays, based on experimental work done for some years, has now been possible. This system will be of great assistance in protecting users from losses easily incurred through wrong use of these new complicated chemicals, and in assisting manufacturers in their production. In view of the great potential value of these hormones—for such diverse purposes as encouraging the setting of fruit, in thinning overcrowded fruit, and weed control—this development is of considerable economic importance.

Soil surveys of the Kaingaroa Plains have revealed broad correlations between soil types and tree-growth characteristics. This information possesses much interest and use to the State Forest Service in its development of the timber resources of this area, and will be a guide for timber production and management and utilization elsewhere.

The efficiency of boric acid in controlling *Ambeodontus,* the New Zealand wood-boring insect second in importance to *Anobium,* has been proved during the year. This result means that New Zealand timbers used for building and furniture purposes can now be proofed against the three prevalent boring insects by the use of boric acid treatments. In application, the results of this research should effect very considerable savings each year in checking the losses in timber due to the ravages of insects. In view of the necessity for expanding the use of lower grades of indigenous timbers, and more extensive use in the future of exotic softwoods, these results possess distinct economic importance.

In the tobacco industry the use of methyl bromide as a soil sterilizer in seedling beds has proved very efficacious and appears likely to supplant to a large extent the present costly and cumbersome steam sterilization operation. Growers will be able to treat their own soil readily by using methyl bromide, thus effecting considerable annual savings. The use of certain chemicals

applied to tobacco plants when topped have shown their value in checking lateral growth, the removal of which requires a good deal of labour. These discoveries, resulting from persistent research, will render in application considerable financial help to the tobacco industry.

The design by the Applied Mathematics Laboratory of a new sample survey method of collecting agricultural and pastoral statistics is expected to markedly reduce the cost incurred by the Census and Statistics Department in collecting this information.

Open hearth fires normally give a heat efficiency of the order of 10 to 15 per cent of the fuel consumed. Investigations have shown that, with proper design and control, efficiencies of over 50 per cent may be secured from enclosed stoves, the cost of which installed does not exceed that of the ordinary chimney and grate. In view of the need for conservation of our coal resources, these results point to the possibility of considerable savings each year in the use of coal for domestic heating.

The use of radio-active cobalt and iridium for X-ray examination of welded metals and castings has been introduced and used in testing steel conduit to be used in hydro-electric installations.

The Leather and Shoe Research Association has further extended the work done last year in modifying New Zealand fish-liver oils for the production of chamois leather, and in the use of vegetable oils for oil tanning. The new process produces stronger leather and enables white washable gloving leathers to be manufactured without the need for bleaching. Bark from *Pinus radiata* trees has been shown as a possible source of tannin, and the harmful influence of high temperatures upon pickled pelts in storage and transport has been demonstrated.

The Pottery and Ceramics Research Association has investigated extensive deposits of ballclays from Canterbury, Otago, and Southland, and shown that for ceramic manufacture they equal in quality any such deposits found elsewhere in the world.

These examples selected from the achievements of the year's work will serve to indicate the distinct economic results accruing to the scientific work pursued in various branches of the Department.

RESEARCH COUNCIL

The Department is greatly indebted to the members of the Council for the close personal interest they have taken in the work of the Department, for their valued guidance in all matters affecting its welfare and development, and for their advice in the wider field of the bearing of scientific research on the economic development of the Dominion.

The Research Council met on five occasions during the year; in addition, there have been many Committee meetings.

The membership as at 31 March 1952 was—

T. Rigg, K.B.E., M.A., M.Sc., F.R.I.C., F.R.S.N.Z. (Chairman).
J. C. Andrews, Ph.D., M.Sc. (Deputy Chairman).
E. J. Fawcett, M.A. (Cantab.).
E. R. McKillop, O.B.E., M.I.C.E.
R. O. Page, D.Sc.
H. D. Purves, M.Sc., M.B., Ch.B.
J. M. Ranstead, Bledisloe Medallist, and Dip., C.A.C.
W. Riddet, B.Sc. (Agric.), N.D.A., N.D.D.
D. F. Sandys Wunsch, M.A. (Oxon), B.Sc. (McGill), M.I.Chem.E., Assoc.Inst.M.M.
F. R. Callaghan, M.A. (Secretary).

EXPENDITURE, 1951–52

The net expenditure for the year amounted to £1,036,581. The following was the expenditure incurred in the various branches of the Department:—

	£
Head Office	58,769
Research investigations	375,405
Dominion Laboratory	125,840
Dominion Physical Laboratory	207,410
Geological Survey	56,187
Geophysics Division	88,424
Information Bureau, Scientific Liaison Services and miscellaneous services	64,913
Auckland Industrial Development Laboratories	30,074
Grants to Universities and agricultural colleges	37,030
Grants, statutory and miscellaneous	20,181
Grants to incorporated Research Associations	31,700
	1,095,933
Less recoveries	59,352
Net expenditure	£1,036,581

STAFF

The numbers of staff of the Department at 31 March 1952 was as follows:—

Head Office and District Offices (78), Information Bureau (27), Occupational Psychology Research Section (4), Scientific Liaison Services (11), Animal Ecology Section (7), and miscellaneous (11) 138

Dominion Laboratory (140), Fats Research Laboratory (17), and Geological Survey (60) 217

Applied Mathematics Laboratory (16), Botany Division (29), Crop Reserach Division (45), Entomological Research Station (11), Fruit Research Station (23), Grasslands Division (81), Hop Research Station (2), Plant Diseases Division (58), Soil Bureau (76), Tobacco Research Station (5), and Wheat Research Institute (9) 355

Auckland Industrial Development Laboratories (33), Dominion Physical Laboratory (199), and Geophysics Division (70) 302

Total staff, including clerical officers, typists, technicians, and professional officers: 1,012, (952 permanent and 60 temporary). These comprise: professional, 402; clerical, 197; technical, 354; and others, 59.

CONCLUSION

It is pleasing to acknowledge the many advantages which the Department had derived from the good relations which have prevailed with all other Government Departments, Cawthron Institute, the University of New Zealand, University colleges, overseas research organizations, and from both the farming and manufacturing industries.

The Department is also indebted greatly to the Advisory Committees of the Council of Scientific and Industrial Research for their active interest and generous help during the year.

I wish also to express my sincere appreciation of the loyal and efficient service rendered consistently by all members of the staff of the Department.

F. R. Callaghan, Secretary.

REPORTS FROM BRANCHES

ANIMAL ECOLOGY SECTION

Officer in Charge: Dr. K. Wodzicki

RABBITS

Studies have been made on the biology and ecology of the wild rabbit in Hawke's Bay.

Breeding and Mortality.—The rabbit has a defined breeding season lasting from June to the end of February with an average litter size of five at birth. There is a marked mortality between conception and birth. In comparison with England, the breeding season is four months longer. Animals reproducing at the end of the season are mostly young born earlier the same year. The reduction in fecundity of males in the late summer found in England has not been noticed here. Studies on bone development have made it possible to identify young rabbits up to nine months old and to discover the role played by these animals in the growth and structure of the population. In a sample population of 1,020 rabbits collected in January, 80 per cent were under nine months old. However, appreciable natural mortality occurs on the leaving the nest and again three months later.

Parasites.—Information on the incidence and geographical distribution of parasites is being analysed. Some sixteen species of parasites have been found in New Zealand rabbits, and at least one of the species, *Eimeria stiedae,* appears to be of some importance as a factor in mortality among young rabbits.

Feeding.—The study of rabbits' feeding behaviour shows that their food passes twice through the digestive system. A special form of faeces are produced which are eaten direct from the anus. Very little is known about this habit, and in the last eighteen months many animals have been examined in order to determine the details and the times at which it occurs. This knowledge could well be of importance in the application of poisoning methods.

Population.—Studies of a wild population with individually marked animals is providing much information on behaviour and movements. Attempts are also being made to test the reliability of objective methods for estimating the size of a population, which is an essential prerequisite for assessing the effectiveness of any control measures. A long-term study has been started with the co-operation of the Rabbit Destruction Council to throw light on the fluctuations in the rabbit population in New Zealand. A comparison with the information obtained in 1946 shows little difference in the apparent distribution and density of rabbits.

GENERAL

Rats.—At the request of interested authorities, a survey of rats in Christchurch was carried out, and provided basic information on rat control in urban areas.

Conservation.—The Western Taupo survey has shown the suitability of that area for ecological studies, particularly in relation to conservation problems.

APPLIED MATHEMATICS LABORATORY

Director: Mr. I. D. Dick

The work of the Laboratory this year was dislocated for several months through a change of accommodation, the new quarters not being satisfactory until six months after the change had taken place.

CONSULTATIVE AND ADVISORY WORK

Throughout the year the amount of consultative and advisory work has shown no signs of decrease, requests being made for assistance by most branches of the Department and other Government Departments. Typical examples are: analysis of paint records for the Dominion Laboratory; mathematical problems in geology for the Geological Survey; analysis of rabbit growth data for the Animal Ecology Section; advice on design of consumer surveys for the Department of Industries and Commerce; advice to the Navy Board on the statistical aspects of its career system for the promotion of naval officers; and analysis of juvenile delinquency records for the Child Welfare authorities.

PROJECTS

Completed Projects.—The main projects that have been finished and written up for publication during the last year are: the analysis of the results obtained for the New Zealand Standards Institute in its survey of the feet measurements of New Zealand school-children; the correct analysis of experimental results when the treatment effects are both additive and multiplicative; methods for investigating relationship as between observed sets of data; studies on the inheritance of grain weight in wheat; analysis of lifetime fleece-production records; further studies in the analysis of time series data; a doctoral thesis on certain mathematical problems relative to the growth and distribution of biological organisms; the design and analysis of certain balanced incomplete block experiments; the analysis of the results of an experiment to determine the resistance to rust of a large number of wheat varieties; the development of experimental designs peculiarly suited to the investigation of problems in timber technology; and the determination of the accuracy of line transect sampling as a method of assessing the vegetative cover of high-country areas.

Projects in Hand.—The largest project still continuing is the design of a sample survey to replace the complete enumeration previously used to obtain agricultural and pastoral statistics. This work is being done for the Census and Statistics Department, and when completed in August 1952 will enable that Department to collect those statistics much more cheaply than in the past.

Progress is still being made towards finding suitable methods for the assessment of rabbit populations. An unexpected outcome of this work has been the solution of important questions in the theory of transformations, whereby experimental data not previously easily amenable to mathematical treatment can be converted into more tractable forms.

Other work in progress includes: the analysis of the results of a long series of orchard experiments; the study of population genetics using natural populations of Californian poppy (*Eschscholtzia californica*) as experimental material; an attempt to see how far soil types can be differentiated by the statistical analysis of their chemical composition; and a statistical study of the academic careers of science graduates from the University of New Zealand.

AUCKLAND INDUSTRIAL DEVELOPMENT LABORATORIES

Director: Mr. J. B. Brooke

PHYSICS SECTION

Some preliminary work was done on the contaminating effect of volatile material on oil diffusion pumps and possible remedies for this problem. A high-vacuum test bench for experimental and calibrating work has been installed and is ready for test.

Survey of Dusts in Industry.—At the request of the Health Department a survey of the size and quantity of dust found in industry has been commenced.

Noise in Industry.—Work for the Health Department has included measurements of noise levels found in industry. Some attempt has also been made to determine the predominant frequency components of the noises measured.

Calibration and Servicing.—The Section carries out a large number of calibrating and optical servicing jobs for industry, but there has been less this year owing to the increased cost of doing the work and the availability of replacement parts from overseas.

ELECTRICAL SECTION

Medical Instrumentation.—Applications of the arterial and venous pressure recorder have been extended. A technique for determining the nervous conditions associated with varicose veins has been developed. A specially prepared 22-gauge needle is used which allows the equipment to be applied to out-patients. The results may be interpreted to indicate the degree of valvular incompetence or venous block and their locations. Pressures have been recorded during surgical operations, in most points of the circulatory system, in some cases as an essential part of the surgery.

In conjunction with the Design Section, an automatic high-speed injector is being developed for the injection of X-ray opaque dye as used in angiocardiograms.

Work has been done on the assessment of blood flow in skin tubes formed in the course of major skin grafts. Skin temperatures are recorded at several points on the skin tube, using thermocouples, magnetic amplifier, and recording milliameter.

Logarithmic Amplifiers.—An electrical device that provides an output proportional to the logarithm of the input has been required, particularly in the development of the oximeter. Existing methods of producing this result have been investigated and a new simple method suggested. Preliminary tests show the method to be sound, and it will be incorporated in the experimental oximeter.

Ground Vibration Measurements.—Work has been done on the recording of the ground vibrations produced by quarry blasting to ascertain the possible effects on structures in a particular area.

A considerable amount of repair, testing, and calibration of electrical measurement equipment has been undertaken for industry and for other scientific institutions.

DESIGN SECTION

Geothermal Investigations.—The major work for this project has been the design of equipment for the measurement of quantity and quality of steam and water mixtures from the 8 in. bores. This includes a spray-type calorimeter, a steam splitter, orifice meters, and pressure transducers for continuous recording.

A comprehensive report has been prepared on the piping of hot water over long distances, such as would be envisaged if the surplus low-grade energy in the form of hot water were to be used for a district heating scheme.

Equipment and Investigations for the Plant Diseases Division.—A flow-type differential refractometer based on an overseas design was made and is now in use. A soil injector was devised for applying a closely controlled dose of toxic fumigant (chloropicrin). For frost-prevention methods, a radiant heater that burns kerosene is ready for trials, and tests have been made on sawdust-burning heaters. For tests on orchard sprayers, methods of collecting and measuring droplets are being tried, and if satisfactory will be used for size and quantity distribution tests.

Medical Instrumentation.—In conjunction with the Electrical Section, two machines were designed for the cardiac clinic at Green Lane Hospital.

Defibrillator and Heart-massage Apparatus.—This apparatus is for resuscitation after cardiac arrest during anaesthesia and surgery. The machine provided for electrical defibrillation of the heart, a timed shock of 110 volts 1·5 amps. administered by electrodes placed one over each ventricle.

High-pressure Injector for X-ray Opaque Liquids.—This machine is referred to under Electrical Section. A thermocouple head, incorporating glass-to-metal seals, for fitting to autoclaves, has been designed to enable more accurate temperature indication and control of surgical packs during sterilization.

METALLURGICAL SECTION

Mechanical Testing.—The Department has now been approved by the Marine Department for carrying out their test requirements, and this has resulted in a considerable volume of work from firms engaged in ship repairs, pressure vessel and crane construction, and other welded work.

Greater use is being made of the facilities by firms requiring mechanical tests on wire ropes for cranes and lifts, ferrous and non-ferrous castings, concrete-reinforcing rods, and roofing-material.

The amount of work from the Ministry of Works has also increased, mainly owing to the State hydro undertakings.

The higher capacity and more portable dead weight pressure tester has proved very useful for calibration of concrete compression testing machines.

Physical Metallurgy.—A large proportion of this work is devoted to assistance to the metal-working industries. The scope of this work is increasing, and covers foundry practice and materials, inspection of ferrous and non-ferrous sheet and strip for fabrication, and investigation of surface finishes.

Typical examples are investigations of sand-cast plumbers' hardware, of aluminium sheet for spun utensils, of strip sheet for knife blades, spot and seam welding of containers, and of the anodizing of aluminium fixtures.

A number of service failures and corrosion problems have been examined. These include instances of premature failure of white metal and lead bronze bearings, valves, crankshafts, axles, and differential gears from various types of vehicles; and corrosion of ball bearings, magnesium castings, and copper brazed joints.

Heat Treatment.—At present this is confined to the heat treatment of tools and dies of material other than high-speed steels.

WORKSHOP SECTION

The precision workshop has played a large part in producing prototype equipment for the projects mentioned in this report and in addition has carried out a number of special servicing and constructional jobs. These include the machine engraving and circular dividing of several large plotting scales, approximately 5 ft. in diameter; the manufacture and testing of a precision worm and wheel for a milling-machine dividing head; the manufacture and motorization of a miniature vane soil shear tester; and the provision of several batches of waterproof resistance thermometers for measuring the setting temperature of the concrete in the Maraetai dam.

REPORTS AND TECHNICAL NOTES

Six reports and eight technical notes by members of the staff have been issued.

BOTANY DIVISION

Director: Mr. C. M. Smith

HERBARIUM

The limited herbarium space has become even more inadequate with further accessions and steady reorganization throughout the year. Accumulated arrears of routine sorting and tending of the collections were tackled, and the increase of sorted material only emphasizes the lack of space. The herbarium staff dried and prepared for transport overseas the whole of the collections of visiting botanists, amounting to a few thousand specimens. An electrically operated drying cabinet was installed, and the formidable task of disinfecting and poisoning the collections was begun.

EXPERIMENTAL AND FIELD WORK

Agropyron.—The critical examination of the life histories of the naturally occurring strains of species of this genus was continued. During the year, one officer visited Australia to attend a Science Congress, and subsequently to visit Australian colleagues who are doing similar work with other grass species that are suited to "open range pasturage." The work of unravelling life histories and habits of such natural strains of grasses which have not been subjected to formal and intensive methods of cultivation is lengthy and tedious; and it often gives surprising results, not always as favourable as had been hoped. Stocks of true-breeding fertile natural strains of *Agropyron scabrum* have been maintained, and new generations bred without as yet any sign of reduction in fertility or of loss of plant vigour. The oldest such material has now reached the fifth generation.

Other Tussock Grassland Work.—It seems probable that, in view of the importance of these types of plant community in the land economy of New Zealand, these investigations will remain the most economically important activity of the Division for many years. The officer last year recorded as stationed in Christchurch crystallized the results of her investigations into a very good report on a particular area, and this was submitted in final form in August last for publication.

An attempt to co-ordinate the various organizations investigating tussock grasslands problems has resulted in the formation of an interdepartmental Tussock Grasslands Committee, on which the Division has representation and which is hopeful of preventing overlap and of accelerating application of findings. The small plant trial nursery at Molesworth, in the Upper Awatere Valley, has been maintained in operation with the continued assistance of the Lands Department, which during the year generously transferred to the Division a small cottage on the property. This small nursery acts as a local trial nursery for growth under severe conditions of species which have shown promise under conditions of good culture and kindlier soil and climate at Waiwhetu Nursery, near Wellington.

Phormium tenax and Yellow-leaf Disease.—The outstanding success of the year was the long-deferred discovery, by the joint efforts of the Soil Bureau and the Divisions of Botany, Entomology, and Plant Diseases, of the cause of yellow-leaf disease of *Phormium tenax.* The last report indicated that finality was imminent in this matter; and work by the combined team during the year placed it almost beyond doubt that the causal organism is an endemic virus transmitted by an endemic hopper insect *Oliarus atkinsoni.* A paper was published in the *Journal of Science and Technology* on the discovery; and a series

of technical articles has been prepared by officers who participated in the different aspects of the work. Now that attention can be concentrated on a known insect, much more detailed and intensive experiment will be continued in other centres besides Foxton.

Palynology.—The service of regular reports of local atmospheric pollen contents to medical practitioners who forward slides for examination was continued, and over 1,600 slides were received and analysed for this purpose. The two new South Island recording stations were installed, and further, at the request of one of the medical recorders, a second type of exposure apparatus was installed in two stations (gravity collection, as opposed to impact collection).

Honey analyses for pollen content were performed whenever they were sought by the Department of Agriculture, and in one case on samples returned from Britain by the Honey Marketing Association. Peat surveys were continued especially (at the request of the Lands Department) in the area chosen for development at Paekakariki as a major recreational area for Wellington district. Professor Osvald, of Uppsala, who is the leading world authority on peat formation and reclamation, visited New Zealand and furnished useful technical advice and comment to the workers in peat lands.

Water-weeds.—The work was continued; and the systematic survey of aquatic plant distribution was carried a stage further by a field trip through South Canterbury and South Otago, where full lists of aquatic plants were made in numerous swamps, drains, and ponds.

Gardens and Experimental Nurseries.—The task of the year which will have most significance for the future was the acquisition in Christchurch of an area of 10 acres around which all the divisional intensive cultural and experimental work will centre, and which will replace the field station at Waiwhetu. This area should ultimately become a Dominion Botanic Garden of the greatest national interest and importance if adequate and available contiguous land can be added to it. The work of development began during the year.

MISCELLANEOUS

The usual varied assortment of inquiries to the number of several thousands both from New Zealand and abroad was dealt with. The Division for the first time collected diverse plant seeds and catalogued them in an Index Seminum, which was issued to kindred botanical institutions throughout the world. In it were incorporated sections for crop seeds available to recognized research institutions from Crop Research Division and Grasslands Division. The overseas response and reciprocal action was beyond all expectation, and a much increased collection had to be begun for the incoming year.

Another remarkable inquiry was from Kew Gardens for samples of *Cyttaria* fungus to be analysed for vegetable wax content. Adequate collections to provide such laboratory samples were made; but it had to be admitted that there were no possibilities of collection of industrial quantities, even though such a source of supply would have been nationally valuable for a raw material at present procurable only from hard-currency countries at very high prices.

The old vexed question of the fate of the sets of Banks and Solander prints furnished to New Zealand by the British Museum in the early part of the century again cropped up. Opportunity was taken to search thoroughly for them, and, with the co-operation of all institutions that hold sets, a complete inventory was at last made.

CROP RESEARCH DIVISION

Acting-Director: Dr. E. J. Godley

Dr. O. H. Frankel, Director of the Division since 1950, left in November to become Chief of the Division of Plant Industry in the Commonwealth Scientific and Industrial Research Organization.

An Agronomy Section has been established, the general function of which is to obtain such knowledge of the varieties introduced or created and of the land where they should be grown that will lead to their most efficient use.

RESEARCH ON FIELD CROPS

Hilgendorf Wheat.—The analysis of the threshing returns for the season 1950–51 shows that in the counties Marlborough, Malvern, Ellesmere, Ashburton (main subdivision), and Ashburton East, where the bulk of the Hilgendorf was grown (3,291 acres), the average yield of Hilgendorf was 40·4 bushels per acre, compared with that of Cross 7 (31,361 acres), 43·0 bushels per acre. The premium of 1s. per bushel paid for Hilgendorf would thus give a return to the farmer equivalent to 44 bushels per acre of Cross 7. In Ashburton Main the return from growing 1,638 acres of Hilgendorf plus the premium was equivalent to an additional 3·6 bushels per acre of Cross 7.

New Varieties of Wheat.—For the third year in succession Cross 7 was the lowest yielding variety in trials conducted by the Extension Division of the Department of Agriculture. Several of the advanced lines are promising agronomically, but they are all inferior to Cross 7 in baking quality. One of them may become important as a poultry-wheat.

The prolonged wet weather during the autumn and winter of 1951 made it impossible to sow any of the experimental plots at Lincoln. Material prepared for sowing last season will be tested for yield and quality in 1952–53.

Disease Resistance of Wheat.—The work of breeding mildew-resistant strains of Cross 7, Yielder, and Hilgendorf is proceeding. By growing alternate generations in the glasshouse and in the field it is possible to make two back-crosses each year. After two more years the strains will be sufficiently like the original varieties for their resistance to be tested on a field scale.

Wheat Investigations.—Studies on the inheritance of quantitative characters and on mildew resistance are being continued. The technical work on the study of the inheritance of shattering in wheat has been completed, and the statistical analysis of the data is being carried out. A paper on the inheritance of kernel weight has been submitted to an overseas journal.

Oats: Resistance to Lodging.—The material prepared for sowing at Lincoln was sown in the spring, with the co-operation of the Department of Agriculture, at the Invermay Agricultural Research Station at Mosgiel. It was found that the Welsh variety S225 was the only variety not subject to lodging on heavy land. S225 is being tested for yield and milling quality, and has been used in crosses.

Disease Resistance of Oats.—The varieties previously used in crosses as sources of resistance to crown-rust and leaf-rust are not now resistant to all of the physiological races of rust present in New Zealand. An officer of the Plant Diseases Division is assisting in the work of testing the whole of the oat collection in an endeavour to find varieties which may be used in breeding for rust resistance.

Barley Purification.—The purification of the early-maturing and the mid-season fractions of Research barley has been completed, and a start has been made on the production of pure lines of Kenia and Golden Archer for certification.

Barley Variety Trials.—With the co-operation of the Extension Division of the Department of Agriculture and the Canterbury Malting Co., tests for yield and quality of several Scandinavian varieties of barley were continued.

Potatoes.—Virus infection tests this year have confirmed the presence of viruses X and Y in all stocks of our main variety, Aucklander Short Top, and virus X in all stocks of Dakota Red. An extensive survey of the variety Arran Chief in the Tuatapere district has failed to confirm the presence of virus-free crops, but many are very low in virus content.

Further hybrids immune to virus X and to the Victorian strain of Y have been introduced from Australia for breeding for immunity to these viruses.

Scottish and American varieties immune to blight (*Phytophthora infestans*) at Pukekohe for the past three years succumbed to blight this year, indicating the presence of a second strain of blight in the district. A range of hybrids immune to different combinations of strains of blight has been imported from the Scottish Society for Research in Plant Breeding, to assist in determining what strains of blight are present in New Zealand and for use as a basis for our breeding programme.

A commercial preparation of isopropyl phenyl carbamate applied to potato tubers gave effective control over sprouting until November in clamp or shed storage. Treatment seemed to induce almost permanent dormancy in the variety Aucklander Short Top, so that no sprouting occurred even when tubers were exposed to the air. In trials over two years the methyl ester of alpha-naphthalene acetic acid applied to seed tubers gave a higher proportion of table-size tubers than control plots, while tetrachlornitrobenzene produced more seed and less table-size tubers.

Rape.—Further selections from the cross (Calder × Superlative) × Club-root Resistant rape, which had given evidence of aphid resistance in the past, were exposed to aphid attack at a young and hence very susceptible stage. All plants succumbed to attack. Work is continuing with other hybrid material.

Swedes.—Investigations have shown that aphis-resistant swedes support a much smaller aphis population than do susceptible varieties. The differences are apparent at an early stage of leaf development and leaves of resistant varieties develop their maximum resistance at an earlier age than leaves of susceptible varieties. Of some forty-seven lines grown at Lincoln this year, the following twelve had a fair degree of resistance: Wilhelmsburger Otofte (three lines), Vilmorin's white flesh purple top (four lines), Bangholm Wilby Otofte, Granhovsdet Hunsballe, Balder, Vilmorin's white flesh green top, and Calder.

Some lines of Wilhelmsburger Otofte show a promising degree of resistance to dry rot.

Linen Flax.—The backcrossing programme to introduce the rust resistance of Russian varieties, Ottawa 770B, and Bombay to Liral Crown has been extended to include the variety Concurrent, which gives reliable yields in New Zealand. Two of the Russian varieties have good agronomic characters plus a high fibre content of excellent quality, but they are susceptible to one race of rust. They have been crossed with Bombay and Tammes Pale Blue, two varieties in which the rust resistance has a different genetical basis. Of sixteen varieties tested for rust resistance by the Plant Diseases Division, not one showed complete resistance.

Linseed.—In a test of fifty-four varieties for rust resistance by the Plant Diseases Division it was shown that selection for rust resistance is possible within fifteen varieties, and work has been started on three of the most promising —Redwood, Rocket, and Plate. Resistant selections from Koto and B5128 have given enough seed for sowing a yield trial next season. The rust

resistance of Cheyenne and Bombay is being transferred to Golden Viking by backcrossing, and rust-resistant selections from hybrids with Cheyenne are being further selected for early maturity to obtain a replacement for Bison in Southland. A collection of seventy-six varieties was grown and studied in a search for further valuable material.

Lupins.—In an extensive trial with eight varieties the Swedish sweet blue variety Borre was again superior to the New Zealand sweet blue. The non-shattering sweet yellow lupin was again superior to the New Zealand strain, and a pure line of this selection has been increased for further trials. A breeding project is in progress to combine the rapid early development of the bitter pink lupin with the low alkaloid content of Borre and New Zealand sweet white lupins.

Peas.—Trials of bred material have been conducted of early garden peas with higher yield than William Massey and of mosaic-resistant Greenfeast types. A major problem with canning-peas is to obtain a spread of the harvest period. Varieties from the above two projects with a range of maturity dates have been submitted to the Marketing Department, Pukekohe, for a co-operative trial to determine their potentiality for canning.

Breeding for wilt resistance in garden and field peas has progressed three generations during the year. Trials of new lines of blue field peas have been conducted and pure line selection of field peas for certification is continuing.

Lucerne.—Work on the improvement of grazing and hay lucernes is continuing. In addition to those at the Division, plots for the trial of new imported material have been established in the Cass area with the co-operation of the Department of Agriculture. A grazing trial has been established at Lincoln to compare *Medicago glutinosa* with *M. angustifolia.*

Agronomy.—Investigations into forage crop measurement techniques have commenced. An experimental technique using wethers to measure crop yield is under trial. The natural interrelationship between crop and animal are retained in this technique, the results of which can thus be more suitably applied in farm practice.

Though this work is long term, some interesting points have already emerged. The digestibility of rape is not reduced by the tramping, biting, soiling, &c., inseparable from sheep grazing of rape. However, in a 10 ton per acre crop of rape only a little over 50 per cent was used by grazing wethers. Two tons per acre were left as stubble; $1\frac{3}{4}$ tons of leaf per acre was wasted by dropping on the ground and/or tramping in; while nearly 1 ton per acre was undigested and excreted. Only $5\frac{1}{4}$ tons out of a 10-ton crop was effectively used by the sheep.

RESEARCH ON VEGETABLE CROPS

Tomatoes.—Fifteen selected varieties have been grown for intercrossing in a search for a good F1 hybrid combination. Selected hybrids will be used as the basis for a breeding programme which aims to combine earliness with high yield. A small trial has been grown to compare the yield of standard varieties with one reputed to be high in vitamin C (see report of Plant Biochemistry Section), while in another small trial the use of soil blocks for raising tomato plants has been compared with the usual cultural methods.

Carrots.—Selection is continuing in the Holmes Improved carrot to develop a better market type.

Broccoli.—Selection is continuing from four strains and nucleus seed production has been commenced from one line.

Savoy Cabbage.—From single plant progeny trials selected plants were moved into glasshouses for the production of selfed and open crossed seed.

Dehydration.—At the request of the Marketing Department, six lines of cabbages and two of carrots have been grown and are being supplied as they mature for experimental dehydration.

PLANT BIOCHEMISTRY

Vitamin C Content of Stored Potatoes.—Work was concluded this year upon the loss in storage of vitamin C by commercial potato varieties. For the twenty varieties investigated the vitamin C content of newly harvested potatoes was from 0·015 per cent to 0·04 per cent of the fresh weight. Those with a high vitamin content at harvest retained significantly higher amounts of vitamin for longer storage periods, but after five months storage all varieties contained approximately the same amount—*i.e.*, 0·01 per cent of the fresh tuber weight Potatoes grown at Pukekohe tended to have a higher vitamin C content than those grown at Palmerston North, Lincoln, or Gore. This work provides the basis for a more accurate evaluation of the place of the potato in the New Zealand diet.

Composition of Varieties of Chou Moellier.—Chemical analyses of nine selected chou moellier varieties grown in three localities has indicated significant differences in the potential nutritive value of these fodders and differences in composition of crops grown in different localities.

Vitamin C in Tomatoes.—The vitamin C content of a tomato variety reputed to be high in vitamin C has been compared with Standard varieties. The "high C" variety contained 50 per cent more vitamin than normal, but gave a poor yield.

Effect of Virus Upon the Chemical Composition of Potato Tubers.—Virus infection upsets the protein metabolism of the healthy tuber, and this upset is reflected in the amino acid composition of the tuber tissue. An effort is being made to reveal and study these metabolic changes and to develop rapid chemical tests for virus content.

Aphid Resistance in Swedes.—Preliminary work is being undertaken to determine the factors that make some varieties of swedes resistant to aphid attack, as it is felt an understanding of the biochemical basis for resistance would assist in transferring the factors concerned to rape, which is very susceptible to attack. As young leaves are more susceptible than mature leaves, it is thought that the soluble nitrogen containing compounds in actively growing tissue may be essential for maximum aphid development.

Nutritive Value of Fodders.—The Biochemistry Section co-operates in the running of digestibility trials upon different fodders. A trial comparing sweet lupins and rape, both grown and fed separately and together, has shown that considerably greater yield and nutritive value may be obtained by growing suitable crops together and feeding them as combined fodders.

PUBLICATIONS

Four papers by members of the staff have been published or submitted for publication.

DOMINION LABORATORY

Director: Mr. F. J. T. Grigg

The work of the Dominion Laboratory, as in previous years, has been concerned principally with the service and research requirements of other Government Departments, together with some special research projects. Almost all Departments require services periodically, and in some cases—such as the examination of paints, lubricating-oils, coal-supplies, &c.—inter-departmental committees have been set up to eliminate duplication and to assist in organizing necessary research work. The scope of the Laboratory includes both chemical and chemical-engineering services, and certain types of bacteriological work. Examples of the special research

projects are meat research, dehydration of vegetables, certain aspects of forest product chemistry, and the use of radioisotopes. A major investigation during the year was the use of pozzolanas in concrete for hydro-electric dams, and work on the spontaneous combustion of wool was carried further. Staff has again been short for the heavy demands made.

During the year there has been close collaboration between the Director of the Dominion Laboratory and the Director of the Dominion Physical Laboratory at Lower Hutt, which has resulted in greater efficiency and economy.

A table showing the distribution of work among contributors is shown on page 27.

ROCKS AND MINERALS

Research on pozzolanic materials was vigorously pursued. A considerable amount of testing and analysis of materials considered likely to have value as pozzolans was carried out in the Laboratory and two deposits were recommended as suitable for larger-scale tests at the Dominion Physical Laboratory. If the chemical findings are confirmed by the practical trials it will be possible to replace a large proportion of the cement by finely ground natural pozzolans in building concrete dams. The Laboratory is investigating a promising new chemical method of evaluating pozzolans.

In the development of geothermal steam at Wairakei, cementing problems in the bores were investigated. The possibility of corrosion of the Portland cement used for grouting was raised, and tests were made by lowering into a borehole mortar cubes made from Portland cement, aluminous cement (ciment fondu), and a pozzolanic cement. Little corrosion occurred, and it was confirmed that aluminous cement was unsuitable at the temperatures encountered owing to rapidity of setting and low strength. Analyses were made of fifty-one cores from the drilling of the bores.

Analyses were made of many rocks and pure minerals separated from rocks for the Geological Survey, and of nineteen soils from the Cook Islands for the Soil Bureau. In all such work the spectrograph is now used regularly for the detection of unusual or trace elements.

A red boulder discovered by a prospector in the greywacke rock of the foothills of the Tararuas was found to contain about 20 per cent of mercury, as cinnabar and free mercury. The ore was associated with a basic igneous rock in the form of " pillow " lava, but a search failed to reveal any mercury-bearing lode.

Many assays were made for gold, silver, zinc, lead, and copper.

Ocean-bottom sediments from the Chathams rise collected by H.M.N.Z.S. " Lachlan " and containing phosphate nodules were analysed for phosphorus, potassium, and fluorine.

ISOTOPES, RADIOACTIVE AND STABLE

Construction of two small laboratories for the handling of isotopes was started in a building occupied by the Department at Lower Hutt. While the laboratories will be far from adequate for the handling of radioactive isotopes, they will enable chemists to collaborate more closely with the physicists who are already working on isotope problems in this building.

The handling and measurement of the radioactive phosphorus, of atomic weight 32, used in the treatment of polycythemia vera (blood cancer) in the Wellington and Palmerston North Hospitals, was undertaken for the medical staffs.

The isotope of carbon, of atomic weight 14, is radioactive, and disintegrates at an accurately known rate. In solid materials containing carbon the ratio of this isotope to the common isotope, of atomic weight 12, is dependent on the age of the material. By measuring the amount of this isotope remaining, it has been found possible overseas to form a good estimate of the age of such materials as fossil wood. The method is useful because, unlike other geological methods, it gives information on the scale of thousands of years, rather than hundreds of thousands or millions. In the Laboratory, work was done on the methods of separation and purification of the carbon for the measurement of the residual radioactivity. If by this method the age of charred wood embedded in the Taupo pumice showers can be determined, it may be possible to obtain very useful information on rates of erosion and the rates of formation of soils by the weathering of volcanic rocks.

MEAT RESEARCH

The work on the dehydration of meat chunks in molten beef fat under reduced pressure was continued. The effects of different moisture levels on tenderness were investigated. It was found that tenderness could be improved by freezing the meat for about a day before dehydrating. Trials of the process were made at different temperatures to obtain thermal data for the construction of a pilot-scale plant.

After some work on the chemistry of muscle protein, the officer doing this work was sent to Cambridge for further study of this subject. Another officer later commenced work on the chemical changes associated with rigor mortis in beef, which have a direct relation to "weep" and "drip" of frozen meat and its juicyness and resistance to bacterial attack. Apparatus for detecting the onset of rigor in muscles was constructed and used to correlate the onset with chemical changes.

Further study was made of the effect of freeze-drying on meat-spoilage organisms. Owing to the loss of the bacteriologist, this work had to be transferred temporarily to the Auckland district laboratory.

With the object of improving the quality of frozen meat received in Great Britain, a survey was commenced of the conditions under which meat is transported in New Zealand from the freezing-works to the ship's hold. The time taken for each stage of the journey and the temperatures at which the meat is carried are being recorded. The possibility of mechanical loading from wharf to ship is also being investigated. This might be a means of avoiding the frequent delays caused by bad weather.

The curing of bacon has been a source of anxiety to the curers and to the Department of Health, particularly in the northern half of New Zealand. It has been difficult in some districts to avoid the use of boric acid as a preservative, in spite of the fact that it is undesirable on the grounds of possible effects on health. The Laboratory gave considerable assistance to bacon-factories, which are endeavouring to introduce a method of curing in which boric acid is not required.

WOOD CHEMISTRY RESEARCH

As a wood-pulp industry is to be established in New Zealand, study of the pulping properties of *Pinus radiata* wood was commenced. The first project was the preparation of a holocellulose from wood chips of the size used commercially. These were chosen as the starting material, rather than fine wood meal, in order to obtain a holocellulose pulp with the maximum retention of ultimate fibre structure. A study of the relation between hemicellulose removal and strength of the residual pulp was also commenced.

A large quantity of tawa wood (*Beilschmiedia tawa*) was extracted with acetone, and a chemical examination of the extract commenced.

In an attempt to explain the slow drying of paint on totara and some other native timbers, the effect of resinous extractives from the woods of totara and rimu on the rate of drying of linseed-oil was investigated. It was found that linseed-oil to which had been added up to ½ per cent of totarol, ferruginol, podocarpic acid, or the crude mixed resin acids from totara wood, required periods varying from fifteen to twenty-five days to dry to a non-tacky film on glass. When the phenolic group in these substances was methylated or acetylated, they no longer inhibited the drying of linseed-oil. Totarol may be observed as a crystalline bloom on the surface of dressed totara wood, and it seems probable that the slow drying of paint on totara is due to the absorption of totarol and similar substances by the paint.

The preparation of 7-isopropylpodocarpinol from podocarpic acid was almost completed. It is intended to have this substance compared with podocarpinol for oestrogenic hormone activity.

The various published tests for depth of penetration of timber preservatives were applied to the common New Zealand timbers.

A number of phenolic diterpenoids were extracted from New Zealand woods and supplied to the Plant Diseases Division for experiments on the susceptibility of different woods to attack by borer.

In timber preservation the Auckland laboratory continued the research work commenced in 1950 on the extent of adsorption by wood from aqueous solutions of substances of interest in wood-preservation processes. *Pinus radiata* wood was used, and dilute solutions of barium chloride, copper sulphate, sodium dichromate, boric acid, sodium fluoride, zinc chloride, zinc sulphate, and copper chloride.

THE SPONTANEOUS IGNITION OF WOOL

Fires continue to occur in ships carrying certain kinds of wool, and fires in the wool-bins at slaughter-works are still causing heavy losses. It was necessary to continue the investigation of this problem, which was proved to be very complex. While all the factors that contribute to the spontaneous firing of wool are not yet known, certain useful facts have been established. The Laboratory has shown that the fires are confined to " pie " wools—that is, wools separated by a bacterial process from the skins of sheep after slaughter. These wools are not normally thoroughly scoured before export. The presence of considerable body fat in the wool is necessary before a fire can start, but wool grease as is present in unscoured fleece wools is harmless. Catalysts, such as compounds of the metals iron and manganese, appear to increase the risk, but, as far as can be seen at present, metallic catalysts do not appear to be essential for the starting of a fire. The generally held idea that wetness is the cause of firing has been shown to be incorrect, although wetness encourages bacterial growth and the limited heating that this causes. The danger of fires could be avoided by prohibiting the " pie " process or insisting on the thorough scouring of all pie wool, but it is hoped to find a means more economically practicable than either of these.

As a result of the information gathered by the Laboratory the potentially dangerous wools are now segregated in accessible parts of ships, and the fires that occasionally occur can be more easily controlled.

BUILDING RESEARCH

The pozzolan investigation has already been described.

Regular examinations were made of concrete roofing-tiles as supplied to the Housing Division of the Ministry of Works, and technical advice was given to manufacturers for the improvement of the quality of the tiles.

Analyses were made of limestones and shales with the object of finding suitable raw materials for an extension of cement-manufacture.

A study was made of possible methods of hardening the surface of fibrous-plaster building-boards.

An officer was sent to the International Building Research Congress in London, and later studied recent developments in light-weight concrete in Great Britain, Sweden, and the United States. At the Bureau of Reclamation at Denver, Colorado, information was obtained on laboratory methods of testing of cement, concrete, and pozzolans used in dam-construction. In New Mexico and California the manufacture and use of pumice concrete was seen. The conclusion was reached that the use of pumice concrete in New Zealand should be given attention.

The Auckland laboratory co-operated with the Plant Diseases Division, the New Zealand Forest Service, and the State Advances Department by the analysis of many samples of timber treated with boric acid, copper naphthenate, pentachlorphenol, zinc chloride, and other wood-preservatives. Many timber-treating solutions containing a great variety of preservatives were analysed, for which in many instances new methods of analysis had to be devised.

PAINT

Analyses were made of 719 samples of paints, oils, pigments, and related materials. Over 100 inquiries were answered on a wide range of painting problems, including the protection of metals against corrosion.

Accelerated weathering tests were made on 401 test panels.

Inspections of the five paint test fences were made at intervals. No significant deterioration of the test paintings on *Pinus radiata* timber at Tamaki was apparent at the last inspection. The proprietary paints being tested on the exposure fence at Westport are showing some significant changes, particularly where totara primers have been used. There are indications that the use of these primers contributes to premature failure.

Investigations were made of neck varnish for small-arms ammunition, coal-tar enamels for the Wellington City water-supply pipe-line, paints for railway rolling-stock, and various enamels and special-purpose paints.

Laboratory immersion tests on paints for underwater steel are still in progress. Larger-scale tests have also been started in a water-supply reservoir adjacent to Mangahao Power-station. It is hoped to correlate the two sets of tests.

Experiments are being made with the object of improving the storage stability of red-lead priming paints.

The nature of the black staining of oil paints on exterior surfaces which has recently become prevalent is being investigated for the State Advances Corporation. Two series of panels have been exposed on affected houses in Wellington to determine whether the staining is dependent on the composition of the paint. It has been found that application of paint to a badly stained surface does not predispose to staining of the new coat.

GEOTHERMAL STEAM

The Laboratory continued to collaborate with other branches of the Department and with the Ministry of Works in the investigation of the practicability of obtaining power from natural steam at Wairakei. The proportion of gas (mainly carbon dioxide) in the steam from the bores was determined, and samples of gas, condensate, and water were collected from the bores by chemists of the Laboratory and analysed. It is hoped by this means to discover whether the steam is derived from shallow or deep-seated sources. Assistance was given in cementing problems at the bores, and a programme of corrosion testing was initiated.

OIL, BITUMEN, AND TAR

These classes of materials involved analyses of 340 samples—viz., aviation fuels, 24; other fuels, 54; lubricating oils and greases, 119; miscellaneous oils and related products, 38; bitumens, tars, and other roadmaking materials, 105. The usual advisory service was provided on such matters as the suitability of certain Diesel fuels for use in furnace burners, the lubrication of submerged turbine bearings, unsatisfactory locomotive-bearing oil, the pollution of a harbour by fuel oil, and the failure of aircraft engines owing to the use of the wrong lubricating-oil. A large proportion of the work on road materials was put into the formulation of cut-back blends.

PHYSICAL CHEMISTRY

Physical methods and instruments continued to be used as part of the normal technique of chemical analysis in all parts of the Laboratory. In addition, the more specialized physical instruments were applied in a variety of problems. The spectrograph was used for such purposes as the identification of unknown alloys, testing suspected counterfeit coins, checking the purity of lead for batteries, analysing electrical resistance alloys, examining corrosion products, and analysing the ash of lubricating-oils as a means of determining their probable source.

The crystallographic X-ray apparatus was used to identify corrosion products, boiler scales, tarnish films, catalysts, brazing fluxes, ash residues, impurities in graphite, and other crystalline materials. Some problems involving surface films were solved by the use of the Geiger gonimeter head (operated by the Soil Bureau).

Insulation that had failed in a twenty-year-old hydro-electric alternator showed evidence of the migration of anions and metallic cations through the layers of mica. A report was prepared on the technique of measuring pH at temperatures approaching 100°C. A formula for electrically conducting ink was developed for a Power Board. Many electroplating firms were given advice, particularly on means of conserving nickel.

METALS AND CORROSION

Analyses of metals and alloys were made for Government Departments and for private industry to check compliance with purchasing specifications and to estimate the suitability of the materials for various types of service. Many instances of corrosion of metals were investigated in relation to domestic hot-water cylinders, boiler corrosion, corrosion of new pistons owing to unsuitable packing, economizer tubes, dezincification of marine propellers, and corrosion of aircraft engaged in aerial top-dressing. The mechanism of corrosion was investigated in each case, and remedial measures were suggested.

An extensive programme of testing of metals for corrosion when exposed to geothermal steam was commenced at the Wairakei bores.

The erratic failure of shearable rivets holding the wing-tip floats of a flying-boat was shown to have been due to the apparently accidental mixing of duralumin and cadmium-plated steel rivets in the factory. The two kinds of rivets were almost identical in appearance.

The failure of soldered joints in several large hydro-electric alternators was shown to be due to unduly prolonged heating in the soldering, which led to excessive formation of a brittle compound between tin and copper.

Analyses were made for the Soil Bureau of metals buried in the soil in the course of their investigation of underground corrosion.

Automatic-telephone components from Rotorua were studied to determine the effects of the sulphurous atmosphere and to suggest means of combating the very severe corrosion experienced.

CHEMICAL ENGINEERING

For several months the chemical-engineering staff was occupied in fitting out new laboratories and transferring the whole of the chemical-engineering facilities to Lower Hutt. The space available for this work is now adequate, and the equipment is steadily being improved.

Advice was given on a variety of chemical-engineering matters, including industrial processing, drying, dust removal, acid handling, and laboratory design. Two members of the staff accompanied and assisted the visiting American chemical engineer, Dr. G. L. Bridger, in his investigation of fertilizer-manufacturing problems.

Plans for a plant to manufacture phosphorized-pollard rabbit bait were prepared, with special precautions to eliminate the danger of poisoning from phosphorous fumes.

An investigation was carried out on the use of the liquid-solid "cyclone" for the beneficiation of New Zealand clays for pottery- and paper-making purposes. Promising results were obtained down to 20-micron size. This work was discontinued to allow time to be devoted to the more urgent problem of beneficiation of feldspars for the pottery industry. Gravity separation was found to be insufficiently good, but material of acceptable grade was obtained by magnetic separation and flotation.

As a means of economically drying milk in dairy factories of medium size the use of the heat pump was studied.

For the Department of Agriculture a ¼-ton sample of rank-flavoured bush honey was processed to give a bland product, and estimates of the costs of operating this process commercially were prepared.

A pilot plant was constructed and installed in a gasworks to study the removal of sulphur from coal gas by the "Thylox" wet process, as an alternative to the usual iron-oxide dry process, which requires considerable manual labour for its operation, especially with high-sulphur coals.

The fuel-technology advisory service was restricted owing to staff shortage. Visits were made to coal-burning plants and advice given on methods of combustion and boiler-water treatment. Complete boiler tests were made on two installations and simpler tests on ten installations.

COAL

Analyses were made of 763 samples of coal, of which 541 were for the Mines Department and 155 for the Geological Survey. Drilling by the Mines Department provided 530 of the coal samples. The remainder were run-of-mine, face, and outcrop samples. Complete analyses, including calorific values, were made as required. In other cases only proximate analyses or ash determinations were made.

Limestones for spreading in coal-mines to avert the danger of explosions were examined for fineness of grinding and for silica content. Equipment for testing the inflammability of dust from mine roadways was installed by the Laboratory in four coal-mining districts.

TOXICOLOGY AND FORENSIC CHEMISTRY

In the Wellington laboratory, toxicological investigations, carried out mainly for the police, numbered 46, involving the analysis of large numbers of specimens. The poisons found in fatal cases were, in order of frequency, barbiturates, arsenic, carbon monoxide, nicotine sulphate, choral hydrate, cyanide, strychnine, bromide, paraldehyde, Hilatin, Lysol, Jeyes Fluid.

Two further deaths of children occurred owing to the swallowing of "Anthisan" tablets. Further advances were made in methods of analysis for "Anthisan" in organs, and the results were published.

The lung of a man who had ground sand from castings for many years and who died of profound pneumoconiosis was found to contain 42·7 per cent of silica in the ash.

Poisons found by the Auckland laboratory in fatal cases were barbiturates (12 cases, with nembutal predominating), a cresol disinfectant, cyanide, carbon monoxide, nicotine insecticide, arsenic, poisonous fungi, and digoxin.

In three cases of drowning the chloride content of the blood in the right and left ventricles of the heart was determined. The method has been recommended as a means of determining whether drowning had taken place in fresh or salt water. The tests in two of the Auckland cases gave a conclusion known to be incorrect, while the other was inconclusive. It is obvious that this method must be used with the utmost caution.

Determinations of alcohol were made on specimens of blood and urine taken from several persons killed in accidents. In nearly all the Auckland cases the analyses showed that the victims had taken sufficient alcohol to cause intoxication. In all these cases the urine, if examined, contained about 0·1 per cent more alcohol than the blood. This seems to indicate that the amount of alcohol present in the urine is not a good approximation to that present in the blood.

PESTICIDES

For some years the Laboratory has assisted the Plant Diseases Division in certifying commercial pesticides that comply with certain specified requirements as to quality and strength. For this purpose analyses were made of many samples of spraying-oils, nicotine sulphate, copper fungicides, lead arsenate, sulphur, hydrated lime, DDT, azobenzene smoke, aerosols, and plant hormones.

Many analyses continue to be made to find out how much spray residue remains on fruit and vegetables at the time of sale. Apples and tomatoes were tested to determine what amount of mercury spray remains after treatment at varying periods during the season. Apples were also tested for "Lindane" (benzine hexachloride) residues.

Work on the selenium content of apples from trees to which selenium sprays had been applied was continued. Results to date do not indicate any build-up of selenium in the fruit from the spraying of the foliage or the soil.

In conjunction with the Entomological Research Station at Ashburton and the Animal Research Station at Wallaceville, pastures were examined for "Lindane" and DDT residues. Milk samples were examined for DDT.

Bees poisoned by arsenate sprays were found to contain 0·06 mg. of arsenious oxide per 100 bees, which is equivalent to 6 mg. per kilogram. The blossoms suspected of having caused the poisoning contained up to 0·037 mg. of arsenious oxide per blossom.

FOOD AND DRUGS

An important part of the work of the Wellington and district laboratories consists of the examination of food, drugs, and water for the Department of Health, which administers the regulations under the Food and Drugs Act.

The milk sold in districts served by the Wellington laboratory showed more non-compliances with standards than in the previous year. Instances of watering were more numerous, but fewer samples were found to be insufficiently pasteurized. The fact that fewer samples were collected by Inspectors may have some connection with the deterioration in quality. The high standard of the Wellington City supply was maintained.

In all Auckland districts watering of milk was found during the winter months. From Northland and the Waikato, milk low in solids but not watered was received. The Te Aroha pasteurized supply continued to cause concern with regard to low quality and added water. As in other parts of New Zealand, the quality of Auckland district supplies is likely to decline until payment is made on a basis of composition as well as bacteriological quality. The standard for the reductase test could be raised with advantage, and would not be a burden to the milk industry. The Hamilton milk-supply caused concern owing to inadequate cooling of the milk on some occasions. It is pleasing to record that the number of dirty milk-bottles and of samples of milk containing foreign matter in the Auckland district was much less than last year.

The Wellington laboratory made over 300 analyses and bacteriological examinations of drinking-water from all its health districts. Sewage effluents from the Trentham Camp treatment plant and the Wi Tako Prison were examined regularly. Water used for steam boilers was also examined, and treatment suggested where necessary. The effects of sewage effluents on the water of Wellington Harbour and at Moa Point were investigated. Fluorine analyses were made on the water-supplies of Napier and Hastings, where trials are being carried out by the Department of Health on the prevention of dental caries by the addition of minute amounts of fluorine to the water supply. Over 1,000 samples of sea-water taken by the survey ship H.M.N.Z.S. "Lachlan" and the Oceanographic Observatory were analysed in Wellington. Determinations of salinity round the New Zealand coast are comparatively new, and will be of considerable scientific value. Further work on water is described under the heading of "Bacteriology."

Many samples of food on sale to the public were purchased by Inspectors of the Department of Health and analysed by the Laboratory for compliance with the Food and Drug Regulations. These included milk, cream, ice-cream, milk-shakes, bread, sausages, minced meat, alcoholic and non-alcoholic beverages, and smaller numbers of samples of less vital, but still important, kinds of food. A great variety of extraneous or filthy material was found, especially in bread. There seems to be a distinct tendency for this kind of offence to increase in frequency. Canned foods imported into the country were examined for the Customs and Health Departments for the presence of added colouring substances and preservatives.

About half the samples of tripe examined in the Wellington laboratory contained boron compounds present as a residue from the bleaching operation performed by the butchers. In Auckland, 14 samples of tripe contained boron compounds. As a result of prosecutions of the offenders, a change is being made to an alternative harmless process.

Saccharin, although temporarily permitted in certain beverages during the sugar shortage, was actually present in only a small proportion of the samples examined.

Many samples of egg pulp were examined for assessment of quality by laboratory methods.

Drugs, which previously had been sampled regularly in only a few districts, were sampled extensively over a wide area. With comparatively few exceptions the drugs were found to comply with the appropriate standards.

BACTERIOLOGY

Bacteriological examinations were made on many samples of milk, cream, ice-cream, milk-shakes, and other foods. Water and sea-water received particular attention. Many samples were examined from the Manukau Harbour and the Tamaki River and Estuary, and a comprehensive survey of the Waitemata Harbour was commenced in conjunction with the Marine Department. A survey of the micro-plankton (minute aquatic organisms) was made at the same time, and counts were made of the numbers of each type present at different points in the harbour. This will ultimately provide an indication of the effects, if any, of harbour pollution on marine organisms, including fish and shell-fish.

Public water-supplies continued to cause concern, many failing to comply with the high standards commonly regarded as necessary. The results showed that sterilization of water-supplies by chlorine, when applied, was often inadequately controlled and not fully effective in destroying *E. coli*.

Only a small proportion of pasteurized milk supplies failed to comply with the coliform standard of the regulations (absent in one-tenth of a millilitre). The bacteriological quality of pasteurized cream and of ice-cream was much less satisfactory. Milk-shakes, particularly in Auckland, were very unsatisfactory.

Further study was made of the effect of the freeze-drying process on the viability of various organisms responsible for the spoilage of meat.

INDUSTRIAL HYGIENE

The Laboratory provided a chemical advisory and analytical service for medical officers of the Department of Health concerned with the health of workers in industry. The problems arose mainly from potentially poisonous fumes, vapours, and dusts. Lead dusts were the subject of most of the chemical work required. Analyses were made in Christchurch and in Wellington of air in factories handling lead and of urine of employees exposed to lead dust, and of air and vegetation in the vicinity of factories that potentially emitted lead fumes. Investigation of chromium-plating establishments in Christchurch showed that the ventilation was adequate.

Owing to the increasing necessity in New Zealand of using coals that are higher than desirable in sulphur, arrangements were made to install sets of apparatus at suitable points around Christchurch to determine the amount of sulphur dioxide in the air under varying conditions.

SERVICE TO INDUSTRY

Advice on chemical and chemical-engineering matters was given to manufacturing firms. Many inquiries on adhesives, plastics, rubber, textiles, canning of fruit and vegetables, and food problems generally were answered. Assistance was also given to firms, particularly on corrosion and electroplating problems, and on painting and lubrication. A limited analytical service was also provided, particularly on metals and alloys, but work was not undertaken for industry when it could be done by private consultants.

Some analytical assistance was provided for oil companies that had not completed the equipment of their own laboratories. A method of recovering silver metal from X-ray film was worked out. Accelerated weathering tests on paints were made for paint-manufacturers. Samples from shipments of bentonite were tested and certified.

GAS-TESTING

The gas-supplies of the four main centres and of most of the other main towns were regularly examined for calorific value, pressure, and freedom from sulphuretted hydrogen, as required by the Board of Trade Gas Regulations, administered by the Department of Industries and Commerce.

All gas-meters put into service were officially tested and stamped before installation at consumers' premises.

PUBLICATIONS

Four papers by members of the staff were published in scientific journals.

SAMPLES

TABLE OF SAMPLES RECEIVED DURING 1951 BY THE DOMINION LABORATORY, WELLINGTON, AND THE DISTRICT LABORATORIES IN AUCKLAND, CHRISTCHURCH, AND DUNEDIN

Contributor or Department.	Wellington.	Auckland.	Christchurch.	Dunedin.
Agriculture	206	71	482	106
Air	39	..	12	..
Army	13	1	2	..
Customs	131	81	..	66
Education	5	4	40	2
Forest Service	10	210	..	..
Health	5,803	7,591	4,305	3,497
Hydro-electric	230	..	3	..
Industries and Commerce	11	..	..	..
Internal Affairs	5	..	..	..
Island Territories	3	1	..	..
Labour	14	..	..	74
Lands and Survey	3	..	5	25
Local bodies	53	23	1,624	95
Main Highways Board	111	..	..	..
Marine	386	32	..	..
Marketing	26	460	258	70
Mines	625	..	1	..
Navy	201	14	..	19
Plunket Society	176	67	43	..
Police	70	275	176	82
Post and Telegraph	47	14	14	11
Pottery and Ceramics Research Association	11	..	..	..
Printer	15	..	..	..
Prisons	193	..	..	1
Railways	27	3	16	7
Scientific and Industrial Research—				
Information Bureau	141	..	..	..
Auckland Industrial Development Laboratories	7	..	..	..
Dominion Laboratory	118	1	13	23
Oceanographic Observatory	481	..	..	..
Fats Research	2	..	..	..
Fruit Research	10	..	..	114
Geological Survey	327	..	16	17
Geophysics Division	44	..	..	..
Physical Laboratory	47	..	..	..
Plant Diseases Division	182	1,321	..	..
Soil Bureau	26	..	..	..
Industrial	..	3	24	130
Standards Institute	2	..	..	..
State Advances	57	165	..	2
Stores Board	94	..	..	..
Works	291	40	38	29
Miscellaneous	675	..	..	38
Total	10,918	10,377	7,072	4,408
Grand Total	32,775			

DOMINION PHYSICAL LABORATORY

Director: Dr. A. G. Bogle

The Laboratory has five main technical Divisions, which are Mechanical Engineering (including Mechanical Design and Development, Metallurgy, and Workshop Sections), Building and Civil Engineering Research (including Engineering Seismology, Heat, Concrete, and Fire Research Sections), Standards (including Temperature, Radiation, and Metrology Standards, Optical Design, and Physical Instrumentation Sections), Physics (including Geophysics, Nuclear Physics, and Mass Spectrometer Sections), and Electrotechnology (including Electrical Standards, Applied and Basic Radar, Radio Research, Electronics, Electrical Design, and Electron Microscope Sections).

The main functions of the Laboratory, in which it has made progress during the year, are the establishment and maintenance of New Zealand's national standards of physical measurement, specialized assistance to primary and secondary industry and Government Departments, the application of physics and engineering to the development of New Zealand's natural resources, research related to the country's special needs or its unique geographical position, and defence research and development. These five main themes permeate all the work of the Laboratory; every Division contributes to most of them in varying degrees.

MECHANICAL ENGINEERING DIVISION

Mechanical Design and Development

This section provides design services for other sections of the Laboratory, and undertakes mechanical developments initiated internally or by outside authorities. A considerable proportion of the time has been spent on defence projects, but a number of other development projects have been carried on. The 60,000-r.p.m. ultracentrifuge has been completed, and was installed at the Grasslands Division at Palmerston North. A Wood-Anderson seismograph has been designed and made, and handed over to the Seismological Observatory for acceptance tests as a prototype of a number for other observatories throughout New Zealand and at Apia. A river-stage recorder, capable of running unattended for thirty days and producing a continuous record of the level of a river, has been developed for the Soil Conservation and Rivers Control Council, and has been tested satisfactorily.

Metallurgy

Considerable use is made of this section by industry, both for test and examination and for advice. During the year 102 certified reports were issued. A programme of testing of foundry sands has been pursued, detailed tests on the South Island deposits at Green Island and Lookout Point having been completed. An investigation of the reclamation of lead from battery scrap has been completed. With the co-operation of the Industrial Liaison Service, a foundry survey has been inaugurated in which the methods and the products of various foundries are critically examined, and in due course a summary of the conclusions is to be issued for the information of the industry.

With the acquisition of equipment for using the radioactive isotopes Cobalt-60 and Iridium-192 for industrial radiography—especially in situations where mobility is important—the work of the section has been extended.

Workshops

The special facilities of the Laboratory for the machining, heat-treatment, and grinding of tools, gauges, dies, &c., continue to be widely used by industry. Industrial jobs have been handled at the average rate of approximately 40 per month; a large proportion of the machine-shop capacity has necessarily been allocated to defence development work.

BUILDING AND CIVIL ENGINEERING RESEARCH DIVISION

Owing to the loss of all specialist staff and the need for reduced expenditure, the Hydraulics Laboratory has suspended operation. The Fire Research Section is also being closed, to reduce expenditure.

Engineering Seismology

The officer in charge of this section was honoured with the Fulton Medal of the New Zealand Institution of Engineers for his paper describing the work of the section.

Strong-motion Seismographs.—The first of six has been designed and constructed. These instruments are for recording the characteristics of strong earthquakes at strategic points in areas most liable to earthquake shock. The data obtained will be used for improving the design of earthquake-resistant structures.

Analysis of Earthquake Records.—A number of records of strong earthquakes, recorded by the imported Wenner strong-motion seismograph at the Seismological Observatory, have been analysed, and have yielded valuable information.

Vibration Meters.—Sensitive horizontal and vertical vibration meters have been designed and built, and are used for measuring the dynamic characteristics of buildings and other structures.

Shaking-tables.—One shaking-table, which is actuated by a commercially available vibration exciter, has been built and used for testing geophones at frequencies between 10 and 100 cycles per second. Another shaking-table, which is driven by a mechanical crank and connecting-rod system, has been installed on a concrete base, and has been used for testing Hallade track-recording machines for the Railways Department.

Otahuhu Substation.—Readings were taken, on three occasions during the year, of stresses in the reinforcing-steel and in the concrete and of soil pressures under the foundation slab of the control building at this substation at various stages in its construction. Instruments for obtaining this information were installed during the early stages of construction of the building in 1950–51. This work is being done for the Ministry of Works.

Strain Gauging.—Investigations have been carried out on the long-term stability of resistance strain gauges, on the use of these gauges when stuck on to concrete surfaces, and on their protection when placed on the steel of reinforced-concrete structures. Improved "embedded" strain gauges for concrete are also being developed.

Bridge Testing.—Static and dynamic stress measurements have been made for the Ministry of Works on two bridges in the Napier district.

Heat Research

Domestic Heating-stoves.—The calorimeter room opened last year has been in continuous use throughout this year, and tests have now been completed on a range of imported free-standing solid-fuel-burning domestic stoves using New Zealand fuels. Efficiencies of from 45 per cent up to over 70 per cent have been obtained with most of these under prescribed control conditions. As the domestic open fire has proved to exhibit normally an efficiency of only about 15 per cent, fuel saving of from 60 per cent to 80 per cent should be possible by replacing an open fire by one of these stoves.

Space-heating with Electricity.—Some attention has been given to improved methods of space-heating with electricity in order to ensure that, where this means of heating is desirable, an optimum return may be secured for the electrical energy expended.

Thermal Properties of Concrete.—Work on the transmission of heat through concrete and aggregate samples has been undertaken, at the request of the Ministry of Works, with a view to providing data for the design of cooling plant for the concrete dam structure at Roxburgh Hydro. This work is associated with that on the thermal expansivity of concrete materials mentioned under "Metrology."

Concrete Research

Pozzolana Project.—This has formed the main and most important activity of the section. Preliminary chemical work at the Dominion Laboratory has indicated that a number of natural deposits are pozzolanic, and engineering tests are in progress to confirm this. If the deposits are proved, a very considerable saving in cement will follow, together with improved properties in the concrete. This is a large project, involving substantial quantities of different aggregates, cements, and pozzolanic materials.

Grouting of Boreholes.—One of the problems in the geothermal investigations at Wairakei has been that of grouting bores, because of the high temperatures and pressures. A preliminary investigation of the physical problems has been made, and will be continued when some of the chemical aspects of the problem have been further investigated.

Testing of Materials.—The testing facilities of the Laboratory have been extended by the installation of a 100-ton testing-machine. A series of strength tests on *Pinus radiata* has been completed for the purpose of assisting in the formulation of a building code for the use of this timber. During the year, assistance has been given to numerous manufacturers of concrete and cement products by testing manufacturing methods and products and by detailed advice.

STANDARDS DIVISION

Work in the establishment of the principal national standards of measurement has gone ahead, governed primarily by the rate of delivery of basic equipment from overseas standardizing laboratories. Three items of particular importance that have arrived and are being put into commission are a Hilger Muller double monochromator for the Photometry Section, a full range of precision standard thermometers for the Temperature Section, and a pair of mercury 198 isotope discharge lamps for the Metrology Section (a gift from the National Research Council of Canada) that are expected to permit a marked improvement in the accuracy of interferometric measurements as compared with that obtained with cadmium lamps.

Statements of calibration work have been issued for 168 separate instruments other than limit gauges.

In the sections where effort is available apart from that used for establishment and maintenance of standards of measurement, research work on cognate subjects is being carried on.

An approach is being made through diplomatic channels to the Metric Convention to seek New Zealand membership.

Temperature Standards.—Most of the work of the section has been associated with calibrations and the techniques of precision liquid-in-glass thermometry.

Other work includes the development of an instrument for temperature measurement in hot springs which uses a water boiling-point reference, and the investigation of a method for measurement of the heat produced by certain micro-organisms.

Photometry and Radiation.—The section, though not fully equipped, has performed calibration work, particularly for light-meters. Work has continued in the improvement of artificially lighted cabinets for use in plant growth experiments. Another activity has been the evaluation of various reflecting materials for traffic purposes. Spectral intensity measurements made on the sun and sky have been analysed and correlated and prepared for publication.

An instrumental set-up has been developed for the photometry of sub-standards for aircraft instrument dials.

Metrology.—Some 150 limit gauges and other engineering components have been inspected. Interferometric methods have been used to determine the mean coefficients of expansion of rocks and concrete-making materials, and initial work has been done on the use of the same methods for calibration of slip gauges in terms of the cadmium red radiation.

A structural jig having a major dimension of about 25 ft. was laid out and inspected for the engineering workshops.

New Zealand standards of gravitational force are now well established, and eleven engineering testing-machines have been calibrated in various parts of the country by means of proving appliances.

Optical Design.—The section provides services of great value to the rest of the Laboratory. Designs include a special condenser for an aerial photogrammetry equipment, collimating lenses for the Army, and a complete optical system for a standard disappearing-filament pyrometer. The optical workshop has been fully occupied in making up systems designed in the section (*e.g.*, a fast spectrograph) and in servicing work. A new aluminizing plant has recently been added to its equipment.

Instrumentation Section.—The resources of this section have been used almost exclusively for internal purposes—work for Geophysics and Standards taking first place. Two models of an original and ingenious instrument for measuring the temperature in geothermal boreholes (" geothermograph ") have been put into the field.

Results of experimental work with the locally developed *vg* recorder (for aircraft performance research) have been submitted to the Royal Aircraft Establishment, Farnborough. The form and performance of the experimental model have been approved, and a production model is now to be made.

The section has also calibrated numbers of sub-standard pressure gauges, aircraft instruments, anemometers, speedometers, and industrial temperature meters.

PHYSICS DIVISION

In addition to the work recorded in detail below, this Division made a substantial contribution to the total of effort expended by the Laboratory on defence research.

Geophysics

Investigations in Thermal Area.—Measurements of temperature and heat output of exploratory holes at Wairakei have continued. In this work the geothermograph developed by the Physical Instrumentation Section has been especially valuable. In conjunction with Geological Survey, measurements of natural heat loss from fumaroles, geysers, hot springs, and steaming ground have been made, and an estimated total heat output for the Wairakei investigational area arrived at. New instruments for heat-discharge measurement on steaming ground have been constructed and are now in use. During the year the large steam calorimeter was fitted up for the recording of all pressure and temperature data during runs, and remote reading of water-level. Results of all observations made at Wairakei since the beginning of the drilling programme in May 1950 up to September 1951 have been collected in report form.

Moore's Valley Field Station.—Records of wind and power output from a small wind generator have been taken over a period of more than a year. A furnace for annealing high-permeability alloy for fluxgate magnetometer cores has been built, and completed cores are now being made in quantity and of higher quality than imported cores. Several special fluxgate magnetometer development projects are in progress. Recording of natural potentials over short baselines has been continued, and a few recordings of short-period atmospheric-pressure variations made. Apparatus for measuring the remanent magnetism of rock specimens, although not in its final form, has been in use and given satisfactory results.

Other work of a routine nature includes measurement of susceptibility of rock specimens and miscellaneous maintenance work on geophysical-survey equipment. The section recently devoted a considerable part of its effort to assisting with the deep crustal structure project.

Nuclear Physics

Equipment for assessing the age of carbonaceous materials from the proportion of carbon-14 isotope present is nearing completion; this calls for instrumental techniques of a very high order.

Equipment has been developed and used for the measurement of radio-activity in hot waters, gases, fumaroles, boreholes, and sinters at the Wairakei geothermal project. Measurements are still in progress as part of the programme of physical investigation of the thermal activity.

Problems associated with clinical use of radio-phosphorus in New Zealand hospitals are still under study, and certain hospitals have been assisted in specific applications of this new method of treatment.

A new vacuum system for evacuating and filling Geiger-Muller counter tubes to the required pressures is under construction. Research work on an alternative method of counting radioactive disintegrations by means of the scintillations produced in phosphors has been started.

Mass Spectrometer

The construction and assembly of the mass spectrometer is almost completed. Considerable delay was experienced during the year while waiting to move to new laboratory space. Some parts needed redesigning, and this has been done. The mass spectrometer will be used for gas and isotope analysis, at first in geological work and then in biological and other research where stable isotopes may be used.

ELECTROTECHNOLOGY DIVISION

The Electrical Standards Section is now attached to this Division for technical help during the setting-up of its standards. Two new sections have been formed: Electrical Design, for new electrical and electronic engineering developments both within the Laboratory and for outside authorities; and Basic Radar, to establish a body of information on new radar developments, especially in centimetre wavelengths.

The needs of defence research and development work made considerable demands on the effort available in the Division during the year and affected the apparent progress in some sections.

Electrical Standards

The basic standards—Weston cells and 1-ohm resistance coils—are now being delivered, and are being incorporated into the national standards by means of apparatus developed in the section. During the year the procedures that will be required to apply the new standards in practice have been used, but need further development.

Regulations defining the legal position of electrical standards have been discussed with interested parties and drawn up preparatory to gazetting.

Applied Radar

Microwave Meteorological Radar.—A modification to give a clearer display has been tried on one set, and is to be incorporated in all four. The fourth set has not yet been installed.

Microwave Vehicle-speed Indicator.—This has been in use for some time, to the satisfaction of the Transport Department. It is probable that a number of these instruments will be wanted, and an improved design is being considered.

Basic Radar

This new section is intended to work on fairly long-term projects that will add to local knowledge of basic techniques, and which may afterwards be applied to practical radar. Work is being directed towards waveguide circuits, especially the close control of the frequency of a Klystron oscillator, and the optimum parameters of centimetre-wave receivers.

Radio Research

Properties of the Ionosphere.—Equipment for observing rapid fading of signals received by reflection from the ionosphere, and for the study of ionospheric winds, is complete and is being tested. The collection and analysis of data on ionospheric storms has been undertaken during the year. An engineered model of the new ionospheric sounder is being made to facilitate local manufacture of a number for the Geophysical Observatory.

Medium-frequency Ground Conductivity Survey.—After the survey had covered a considerable part of the North Island it became clear that the observed variations in field strength were not caused primarily by ground conductivity. The primary cause of variation is being studied.

Microwave Propagation Studies.—The report on the Canterbury Project has been published. A programme of radio propagation on 3 cm. and 9 cm. wavelengths (10,000 and 3,000 Mc/s) across Cook Strait has been completed. Some further work is intended to investigate the deep fading encountered and to determine the suitability of a rather lower frequency.

Radio Measuring Instruments.—An instrument for measuring the admittance of a medium-frequency aerial has been developed. An instrument for finding the intensity of a radio field at medium frequencies is well advanced.

Electronics

Quartz-crystal-controlled Clocks.—Work has continued on the development and manufacture of three clocks for the Seismological Observatory. The main components have all been developed, and the complete instruments are being assembled for test.

Quartz-crystal Preparation.—The apparatus for the Post and Telegraph Department has been assembled, and the technique of mounting crystals has been developed. The change of frequency of a crystal during the mounting process is now being studied.

Acoustics.—There is an unsatisfied need arising from various sources for acoustic measurements. Measuring facilities are being acquired on a limited scale.

Frequency Measurements.—Demand for the calibration of wavemeters and for other laboratory measurements of frequency is beginning to grow. A standard equipment, to be used in conjunction with and superior in accuracy to the existing secondary frequency standard, has been obtained and is being erected. It is regarded, amongst other things, as a useful reinforcement for the Post Office standard at Makara.

Service and Testing.—Various electronic instruments have been repaired for industry when this work has been beyond the capabilities of local firms. Testing work has included tests of switches, switchboard materials, plugs, and sockets for which State Hydro approval is to be sought; frequency measurements of wavemeters, quartz crystals, and tuning-forks; and tests on motors, ignition coils, dry cells, heating panels, tape recording dictaphones, and copper wire.

Electron Microscope

The demand for this facility is increasing, and may before long justify the existence of a second microscope somewhere in New Zealand. Clay samples are examined regularly for the Pottery and Ceramics Research Association, and numerous biological specimens for dairy research, the Plant Diseases Division, animal research stations, and other authorities.

A complete technique has been worked out for the estimation of concentration of tobacco mosaic virus, and the results are being compared with the results of chemical and pathological tests. The ultramicrotome is now being made, and the work on bull sperm awaits its completion.

Work has begun on observations on the surface of quartz when ground, etched, and polished. This is of fundamental interest in the study of surfaces, and may throw some light on the ageing of quartz oscillator plates.

PUBLICATIONS

Six articles relating to the work of the Laboratory have appeared in technical journals, and thirty-seven Laboratory reports were issued.

ENTOMOLOGICAL RESEARCH STATION

Director: Dr. D. Miller

GRASS-GRUB *(Odontria zealandica)*

Insect Parasites.—The officer stationed in Australia for the past six years has now returned after successful completion of his task of finding and sending to New Zealand such parasites as may be useful against grass-grub. Virtually nothing was known of the parasites in Australia, so the project has meant breaking new and difficult ground; the knowledge gained about the insects will be of value to other countries as well as to New Zealand. The selected parasites belong to sixteen species, and 14,578 pairs were collected and successfully forwarded. It will be some time before the parasites that are establishing will reach a stage when their influence can be noticed.

Parasite Worms.—Mass rearings of *Neoaplectana glaseri* resulted in stocks of ensheathed nematodes amounting to approximately 500 million individuals; in this work, technique had to be developed to safeguard the cultures from bacterial contamination, which tended to reduce the yield. Forty-eight field inoculations in addition to experimental plot inoculations were made, and parasitized larvae of *Odontria zealandica* have been recovered from the plots.

Chemical Control.—The promising results secured with the application of superphosphate plus DDT and benzene hexachloride are being maintained, though certain complications have arisen in parts of the North Island and are being closely studied.

Two areas of severely damaged young lucerne were reported; one of these was treated in December with the recommended DDT superphosphate, which controlled the infestation, while the untreated area had been destroyed by March.

Studies were made of the different methods of applying DDT superphosphate—by aeroplane, spin-dresser, top-dresser, and through drill tubes. The results indicated that the finer DDT dust was lost in direct proportion to the height of application above ground-level.

Phytotoxic Studies.—In co-operation with the Dominion Laboratory, a commencement has been made on these studies in relation to pasture.

Zootoxic Studies.—Wallaceville Animal Research Station has undertaken studies on the influence of DDT superphosphate on animals grazing on treated pasture.

Biology.—Oviposition preference tests have been set up on plots having different plant cover of different height and density; included also are plots having no plant cover, as well as plots subjected to different types of cultivation. In the light-trap experiments over 97 per cent of the trapped beetles were males.

GENERAL

Oxycanus.—Heavy infestation of this caterpillar developed on areas treated with insecticides used for grass-grub. A comparison is being made of the effects of DDT and Lindane.

Tussock-moth.—The areas of deteriorated tussock treated over a year ago show that the treated areas where plots have been fenced in are noticeably better than unfenced plots, while there is no difference between the unfenced treated and untreated areas. At present it appears that the exclusion of grazing animals is the main factor in the tussock improvement, but the work is being continued in order to secure more definite information.

Insecticides and Earthworms.—A study of the influence of DDT and benzene hexachloride, used in the control of grass-grub and *Oxycanus,* upon earthworms has been taken up, but the results will not be analysed for a few months.

Aphis of Crucifers.—In the big populations of *Brevicoryne brassicae* that developed this year a high mortality was caused by a greenish-blue mould, and as a result cruciferous crops made a good recovery. Experiment showed that healthy colonies of aphids could be artificially infected with this fungus.

Clover Case-bearer Moths (Coleophora spissicornis and *frischella).*—A survey of white-clover areas in Marlborough and Nelson revealed no high populations this season, though there was considerable damage in North Otago. Work is proceeding on the biology of the moths and on field control with DDT and Lindane.

A valuable report on parasites has been received from Europe, indicating that they are the chief factor there in controlling *C. frischella.* Ten different parasites have been found, and four are thought suitable for introduction to New Zealand; it is hoped to bring these in during 1952–53.

Red-clover Thrips (Haplothrips niger).—A study of the biology and field habits of this insect indicates that it causes serious reduction in the yield of red-clover seed through a shrivelling of the developing seed.

Cinch Bug (Nysius huttoni).—A wet season prevented definite conclusions being reached from the preference feeding trials. A study is being made on the callousing influence of the insect on cruciferous crops. The life cycle and habits have been studied; the insect is diurnal and responds directly to direct sunlight.

Phormium Insects.—It has been proved that *Oliarus atkinsoni* is a vector of yellow-leaf disease. Field tests revealed that a complete kill of all nymphal forms could be obtained by flooding phormium plantations to a depth from 2–3 ft. for a period of fourteen days. Observations are being made on other possible insect vectors of yellow leaf.

Green Vegetable-bug (Nezara viridula).—The egg parasite (*Microphanurus basalis*) has successfully established in the Auckland Province. Earliest liberations were made at Bay of Islands, and this year 90 per cent of *Nezara* egg rafts were found parasitized, with the result that the bug did not interfere with vegetable-growing there until late summer. Later liberations have been made at Dargaville, Auckland, and Nelson.

Rabbit Myxomatosis.—Assistance has been given to the Department of Agriculture in the selection of sites for liberation of the virus, and a limited survey of possible insect vectors of the disease has been made.

Humble-bees (Bombus spp).—Research in New Zealand and North America indicates that *Bombus ferridus* should be introduced from Canada to help fertilize red clover and raise seed yield.

FATS RESEARCH LABORATORY

Director: Dr. F. B. Shorland

BUTTERFAT INVESTIGATIONS

With the completion of the ester fractionation analysis of two-monthly samples of butterfat from the Rangitaiki Plains Dairy Co., Ltd., accurate information on the changes in butterfat composition that occur during the season has been provided for the first time.

The most marked changes in fatty-acid composition have been shown to occur when the season, which begins towards the end of July, has advanced three to four months. At the beginning of lactation the C_6–C_{14} saturated acids comprise 18·6 per cent and the C_{18} unsaturated acids 29·5 per cent of the total molar content, but the proportions change in a regular pattern to 26·9 and 23·4 per cent respectively in November, and then gradually return at the end of lactation (May) to proportions similar to those at the beginning of the season. Although these changes in fatty acid composition involve a general compensation between the C_6–C_{14} saturated acids and the C_{18} unsaturated acids, the balance is not precise. For example, in July the low value for the C_6–C_{14} saturated acids (18·6 mols per cent) is compensated for by high values for the C_4 and C_{16} saturated acids respectively, as well as by high values in the C_{18} unsaturated acids. In May, however, the low value for the C_6–C_{14} saturated acids (20·1 mols per cent) is compensated for by a high content of stearic and of C_{18} unsaturated acids, the butyric acid content being at a minimum. Palmitic acid, which comprises about 22–23 mols per cent of the total fatty acids, tends to remain constant throughout the season. While stearic acid tends to increase (11·3 to 12·2 mols per cent), butyric acid decreases (12·0 to 9·5 mols per cent) as the season advances.

The changes in fatty-acid composition, to judge from the work of other investigators, are consistent with those observed to accompany the progression of lactation and the changes in plane of nutrition. It was not possible to determine with the available data the relative effects of lactation and of plane of nutrition.

The present work, together with that of Cox and McDowall at the Dairy Research Institute, Palmerston North, on the seasonal variations in softening points, iodine value, saponification values, and Reichert values over a four-year period, affords a guide to the seasonal changes that can be predicted in the fatty-acid composition of New Zealand butterfat.

The fact that butterfats with similar fatty-acid composition taken respectively at the beginning and end of the season show a maximum difference between softening points indicates that the physical properties of the butterfat must depend on the mode of combination of the fatty acids (their glyceride structure). Further work is required to elucidate the nature of butterfat.

The isolation last year of minor proportions of branched-chain acids, which had not hitherto been recorded as occurring in natural fats, represented a considerable advance in knowledge. The published details have resulted in many inquiries from various parts of the world. In addition, the Nutrition Research Department of the Medical Research Council has collaborated by undertaking experiments to determine the nutritive value of these newly discovered constituents. The work so far completed in this Laboratory points to the occurrence of a C_{17} iso and a C_{17} anteiso acid, a C_{18} branched acid, as well as a multi-branch C_{20} saturated acid.

RESEARCHES ON MEAT FATS AND TALLOW

Investigations on the nature of meat fats has been continued, and progress has been made regarding the determination of the fatty-acid composition of the lipid constituents present in ox depot-fats.

The highly unsaturated linolenic acid, which is the main fatty-acid constituent of grass and which is found abundantly in the tissues of pasture-fed horses, has been shown from the work now in progress not to be stored to any appreciable extent in beef and mutton animals. The apparent absence of all but traces of linolenic acid in New Zealand produced meat is perhaps fortunate as recent overseas work has shown that stale horse meat when fed to animals may be the cause of yellow fat and of paralysis. These disorders are thought to be associated with the high linolenic acid content of the meat.

During the course of the year the ante-iso C_{17} saturated acid found in butterfat was isolated from beef fat, and in addition d-14-methylhexadecanoic acid was obtained from mutton tallow.

As stated in last year's report, complaints regarding the keeping quality of New Zealand mutton tallow have been received from Great Britain. Methods for determination of peroxide value have been studied, and it has been found that the recently published dichlorophenolindophenol method, which gives higher results than the iodometric method, is incorrect owing to interference of atmospheric oxygen. The iodometric method has been improved, a new reagent having been developed which, through elimination of blank titrations, leads to more precise results.

The systematic study of tallow digestion methods has been carried out. Contrary to expectation, high pressures yielded fats of much greater stability than digestion at atmospheric or moderate pressures. This is attributed to the antioxidant action of proteins and their decomposition products dissolved in the fat. Owing to this antioxidant action, little correlation was found between the amounts of trace metals, such as iron, and stability of the tallow.

MISCELLANEOUS

A report has been prepared on the significance of fats in the economy of New Zealand, indicating that exported foodstuffs—including butter, meat, and cheese, considered on a dry-matter basis—consist very largely (71·7 per cent) of fat. Three New Zealand industries (bakery and confectionery, paint and varnish, and soap and candle) alone consumed 17,787 tons of fats in 1949–50 to yield products worth nearly £10,000,000.

Advice and research work has continued to some extent to assist further the fish-liver industry.

Work has also been carried out for the External Affairs Department in connection with the study of deer. The fat content of the marrow has been used as an index of physical condition, enabling significant comparisons to be made between adjacent habitats in the Urewera country.

Wool grease samples have been tested, fish-liver oil standards revised, and advice has been given to industry, Government Departments, and the University in connection with problems associated with fats and oils.

PUBLICATIONS

During the year, twenty-three papers have been written by the staff for scientific or technical publications.

FRUIT RESEARCH STATION

Director: Mr. J. D. Atkinson

Good crops on the three established research orchards made possible a full programme of experiments this season. Servicing work for the Agricultural Department, the New Zealand Fruitgrowers' Federation, and the public has been continued. A total of approximately one hundred specimens was examined for physiological disorders, and some ninety varieties of fruit identified.

POMOLOGY

The Sturmer rootstock trial at Owairaka and trials of similar age in private orchards have been terminated. These trials provided the information on which rootstock recommendations are based. Budwood from a large number of promising apple varieties has been obtained from Canada, England, and Australia, and successfully propagated. Several new varieties of sub-tropical fruit trees have been introduced for trial, including the principal avocado varieties of California. In the ten-year-old lemon rootstock trial, rough lemon has produced heavier crops and larger trees to date than either sweet orange or sour orange. Assistance was given the Australian C.S.I.R.O. in an investigation of methods to control mould wastage in shipments of oranges.

FRUIT NUTRITION

Two mineral-deficiency disorders not previously recorded from New Zealand have been identified, and control measures are being developed. Promising results have been secured from three other trace-element diagnostic trials. Improved growth of young trees at a large fruit nursery followed recommended fertilizer and sterilization treatments. Steam treatment of soil in which apples on Northern Spy rootstock had been grown significantly increased the growth of replant trees on both Northern Spy and M. XII stocks. A new technique is under development for the study of nutrients taken up by the tree. This is part of an investigation into stock/scion relationships designed

to add to our basic knowledge of tree growth, and ultimately to improve manurial practice. A considerable amount of tissue-test data have been accumulated from trees of known manurial history. When standard chemical analysis figures are available from the same samples, the combined data will give the standard nutrient levels necessary for diagnostic work. The natural appearance of potassium deficiency in apples near Auckland last season allowed a direct comparison with English figures, and it was found that potassium requirements of apples were similar in both countries. Fresh attempts are being made to control bitter-pit of apples, as this is a major cause of wastage in some of our most important varieties.

PLANT HORMONES

A certification scheme for plant hormones was formally launched in February 1952 when the first list of certified materials was published. Chief advantage of certification is that all users can buy certified products with confidence, knowing them to be efficient for the purpose for which they are recommended. New methods for improving and speeding up testing are being developed. It has been demonstrated that several distinct chemical compounds will produce symptoms on tomatoes and grapes that are indistinguishable from those produced by 2, 4-D. This is an important point, as diagnosis of hormone damage is dependent at present on visual symptoms. The sodium salt of 2, 4-D has been shown for the second successive season to give good control of pre-harvest drop in sweet oranges. This treatment is now being rapidly adopted as standard commercial practice in orange-growing districts. Chemical thinning of apples is showing considerable promise and has already been adopted on a small scale by a number of private orchardists. Trials of hormones claimed to increase the resistance of fruit-trees to frost were inconclusive, as there were no serious frosts in Otago.

STORAGE

It was clearly demonstrated that the common practice of holding Sturmer apples in shed storage for several days or weeks is most detrimental to their future storage life. If labour can be found to get apples packed and into cool store immediately, a major source of wastage will be eliminated. The effects of chemical thinning and anti-drop hormone sprays on storage behaviour are under examination. Work has also been started on pre-harvest sprays to reduce grey-mould of pears. Results of gas-storage experiments with apples are being assembled for publication.

VIRUS

A survey of stone-fruit orchards in Central Otago showed that virus-like symptoms are widespread in cherries and plums, but comparatively rare in peaches and apricots. It is apparent that several viruses are present, and probable that mixed viruses occur in many trees. In collaboration with Plant Diseases Division a start has been made on the identification of these diseases. As an immediate measure to reduce spread of virus, several budwood trees showing suspicious symptoms have been condemned.

FROST

Results from five years' artificial freezing experiments have been brought together in the form of a list of temperatures dangerous to blossom and fruit of the two main apricot varieties, and this is now being published.

MISCELLANEOUS

Of several materials tested, a bituminous compound gave the best all-round results as a wound dressing. Inclusion of hormones in wound dressings was found to be of no practical value. Attention is now being given to the incorporation of fungicides to ensure that fungi cannot penetrate these dressings.

Acetylene-operated bird-scarers that were tested two years ago have now been widely adopted by cherry and grape growers.

PUBLICATIONS

The staff contributed wholly or in part twenty papers to scientific and technical publications.

GEOLOGICAL SURVEY

Director: Mr. M. Ongley

Mr. M. Ongley retires on 31 March 1952, and Dr. L. I. Grange (from the Soil Bureau) succeeds him as Director.

Accommodation is now so restricted at the Wellington office—both for personnel and for storage of reference collections, the basic records, and information gathered over the years—that officers are handicapped in carrying out their work. At present the Paleobotany Section is housed in a separate building with a section of the Botany Division, and though this arrangement is fairly satisfactory in that co-operation between these sections is highly desirable, further subdivision of the respective specialized groups now housed at The Terrace is undesirable. Accommodation at Rotorua is also a serious problem, for the quantity and quality of work has definitely been affected by cramped conditions.

The death of Dr. H. J. Finlay, Micropaleontologist to the Survey since 1937, is recorded with deep regret. After a brilliant academic record, Dr. Finlay devoted much of his time to paleontological research, and following his appointment to the staff pursued his investigations of Foraminifera with outstanding success. In co-operation with Dr. J. Marwick, Senior Paleontologist of the Geological Survey, he considerably advanced the knowledge of New Zealand Cretaceous and Tertiary stratigraphy. His untimely death is a distinct loss not only to New Zealand geology, but also to his colleagues in research throughout the world, who numbered him among the foremost authorities in his subject.

REGIONAL GEOLOGY

North Auckland.—Two subdivisions, the Waipoua and the Whangape, of a total area of 640 square miles and comprising the survey districts of Waipoua, Hokianga, Waoku, Mangamuka, Whangape, and Herekino, have been mapped in North Auckland. The geology of Waipoua Subdivision has been written, and that of Whangape is partly prepared. Field-work was commenced on the Maungataniwha Subdivision, of which 100 square miles have now been mapped. The deficiency of water in North Auckland will not permit the maximum potential development of farm lands unless suitable and adequate sub-surface supplies are located; the survey of the area will materially assist in future development by indicating those areas of rocks that should be test-drilled to ascertain their potential yield of water. A paper on "The Rocks of North Auckland Peninsula Considered as Potential Aquifers" has been published. The survey will also show if and where limestone of suitable agricultural grade

exists. Clays for ceramics occur in the North Auckland Peninsula, and any extension of these deposits will be located. Other minerals that have assumed some economic importance in the past are ores of copper and manganese, and though the prospects of any significant extension of these deposits are not hopeful, there is a chance that some may exist. Additional deposits of serpentinite, the known resources of which are now almost depleted, have not so far been located, and the time is rapidly approaching when future supplies of the rock will have to be obtained from the South Island.

Rotorua.—The detailed survey of the Edgecumbe Subdivision, comprising the N.Z. Mile Sheets N 59, 68, and 77, has commenced. The major work of the Rotorua office over the past year was the investigation of the geothermal resources of the Wairakei area for the Ministry of Works. The Dominion Laboratory, Dominion Physical Laboratory, and Auckland Industrial Development Laboratories collaborated in the investigation of an area of 170 square miles at Wairakei. The first stage of this work was completed following eighteen months' intensive examination of the area, and reports have been submitted to Ministry of Works. Close attention has been given the geology of dam sites and related hydro-electric development.

Napier.—Field-work on the Te Aute Subdivision is now completed, and a bulletin is being written. The area examined comprises the N.Z. Mile Sheets N 134, 135, 141, 142, and a strip adjoining the Dannevirke Subdivision to the south along the north edge of Sheet N 146.

A full knowledge of the geology of the country east of the main range of the North Island is essential in elucidating the geologic structure in relation to possible oil traps; much of the area has been mapped in considerable detail by different oil companies, and although the best known structures have been tested without success, it is necessary to place the researches of different investigators into the regional geologic picture. Apart from this aspect, the present work and its future extension is of importance in its relation to water-supply, limestone for agriculture, possible sources of bentonite, and rock suitable for roadmaking and railway ballast. An abundant supply of moulding-sand has been located, and though it does not fulfil the requirements of standard specifications, it is eminently suited to the requirements of the local foundry. Possible sources of pozzolana have also been located.

Ngaruawahia.—The major part of the coal measures of the Huntly-Maramarua Coalfield are concealed beneath a covering of Tertiary and younger rocks, and as the expansion of the mining industry in these coalfields must within the near future extend to areas about which we have little definite information, the resurvey of these fields was necessary to establish the most suitable areas for prospecting and subsequent development. A considerable amount of drilling will be necessary to prove the coal reserves and guide development. About one-third of the potential coal-bearing area has been surveyed and progress reports prepared.

Christchurch.—The regional survey of Amberley and Motunau, N.Z. Mile Sheets S 68 and 69, was completed, and the first draft of the bulletin written. The area contains different grades of limestone, some suitable for agricultural lime; parts of the area are deficient in satisfactory water-supply, particularly over the summer months, and the survey will assess the possibility of remedying the situation.

Balclutha.—The resurvey of the Kaitangata Coalfield was completed and a bulletin written.

Greymouth.—Regional mapping has continued in the Nelson-Blenheim area: the survey of the Reefton and Garvey Creek coalfields has been completed and the geology of these fields is being written. The Kotuku area has been re-examined to ascertain if a more favourable interpretation of the geology as regards its oil potentialities is possible; the prospects are far from favourable, and any further investigation will necessitate drilling to test structure, to be followed by geophysical investigation should the results of test drilling warrant.

Invercargill.—A bulletin covering the Gore N.Z. Mile Sheet S 170 has now been completed and the Hauroko bulletin dealing with an area in Western Southland is being written. The mapping of Nightcaps Sheet S 168 and Morley Sheet S 159 is proceeding in an endeavour to provide additional information to elucidate the complex structure of the Ohai Coalfield. A bulletin embracing the latest knowledge of Nightcaps-Ohai Coalfield is being prepared.

The above summarizes the progress of regional surveys which provide fundamental data for the development of the country's resources; specific problems, as, for example, the survey of the coalfields, require a more detailed survey of particular areas; but such detailed surveys are an enlargement of the regional picture.

SURVEY OF COAL RESOURCES

The geology of the major coalfields, Nightcaps, Ohai, Kaitangata, and Greymouth, is now known in considerable detail, and as problems arise in their development the district geologists are in a position to give ready assistance to the mine management. The Huntly Coalfield is being investigated in detail, and sufficient information is to hand to guide future mining. As the development of the Westport Coalfield does not present any considerable problem to the mining industry from the geological aspect, a resurvey of this field has not yet been undertaken.

The resources of the Reefton-Garvey Creek field, though of considerable economic importance, are not so extensive as those of the major fields: development of this field by Mines Department necessitated a detailed survey, which is now completed.

In addition to the work on the major fields, minor coal-bearing areas have been examined and reported on, and assistance given in their development. Face and run-of-mine samples have been taken from mines throughout the country.

HYDROLOGY

The Water Resources Section of the Survey was established to investigate the underground water resources of Canterbury. Observation wells throughout Canterbury have been measured periodically and the fluctuations of water-level studied and interpreted. Irrigation areas and areas for future irrigation have been given special attention so that any possible harmful effects of the scheme may be detected and avoided. The occurrence of groundwater in connection with drainage and water-supply has been studied.

Similar systematic investigations of water resources have been extended to Otago, Southland, Hawke's Bay, and the Waikato, and the district geologist for North Auckland has attended to the immediate requirements in his area; but there is still an urgent demand for extending these investigations throughout the country. Advice on the development of water-supplies has been given by the district geologist to Lands and Survey, Railways, and Education Departments, and to various local bodies and industries throughout New Zealand.

ENGINEERING AND ECONOMIC GEOLOGY

In addition to the Wairakei geothermal investigation and the survey of the coalfields, dam sites and problems in development of the Waikato and the Braeburn-Longford hydro-electric schemes have been examined, reports prepared, and periodic inspections have been made of these and the Roxburgh scheme. Clays for ceramics and bricks, quartz sands for glass and moulding sands, limestone for agricultural lime and cement manufacture, aggregate for concrete, rocks for roadmaking and protective work, pozzolanas for use with cement, and quarry sites for macadam materials have been investigated and reports furnished.

PALEONTOLOGY

Dr. Marwick, Senior Paleontologist to the Survey since 1920, retired in March. In his subject he ranks as a world authority and with his New Zealand colleagues has systematized and placed New Zealand paleontologic research on sound foundations. He has given unstinted service to the Department and to his co-workers and built up an enviable record of paleontological research.

Much of the work of this group, which is now organized as Macropaleontology, Micropaleontology, and Paleobotany Sections, has been devoted to servicing the district field geologists, assisting research workers at universities and museums, preparing appendices for bulletins, and a good deal of editing of bulletins for publication. Great progress has been made in the recently formed Paleobotany Section, which now enables the correlation of our terrestrial sediments and promises to be of considerable importance in its application to the coal-mining industry.

PETROLOGY

This section also has devoted considerable time to servicing district geologists in identifying rocks and minerals, and in the preparation of reports to accompany bulletins. The mineralogical characteristics of suitable pozzolanas for the replacement of cement in concrete is being investigated in collaboration with other branches.

Rocks, minerals, and gemstones have been identified for industry; for Ministry of Works and State Hydro-electric Department the suitability of rocks as aggregate for concrete and for use with bituminous mixes was investigated; rocks encountered at different dam sites and in test bores have been identified; for Railways Department, the deterioration of concrete tunnel lining was investigated in collaboration with Dominion Laboratory; and for Mines Department, mineral residues from stone-dust were investigated as a possible cause of silicosis. The mineral content of bottom samples from "Discovery II" and H.M.N.Z.S. "Lachlan" was identified. A close examination of the rocks and rock structure encountered in the Rimutaka Tunnel is being maintained and recorded.

PUBLICATIONS

During the year two bulletins and several papers were published; a bulletin on "The Geology of the Wanganui Subdivision" will be available at an early date, and several others dealing particularly with the western areas of Nelson-Westland are in course of preparation for publication.

A "Bibliography of New Zealand Geology Since 1908" was prepared and cyclostyled under the supervision of Mr. B. W. Collins, of the Christchurch office. The Survey is indebted to Professor R. S. Allan, of Canterbury University College, whose manuscript card-index bibliography prepared over the years served as the basis for this work, and to Mr. and Mrs. D. L. Jenkins, Librarians of Canterbury University College, who gave invaluable assistance in its preparation.

GEOPHYSICS DIVISION

Superintendent: Dr. E. I. Robertson

GEOPHYSICAL SURVEY

Director: Mr. N. Modriniak

The activities of the Geophysical Survey were directed almost exclusively into channels of economic importance. Geophysical studies by gravimetric, magnetic, and seismic methods of investigation of the geothermal resources of the Wairakei area have been undertaken. These studies have been extended into the Te Teko area, where wet steam has been explored in a shallow test bore. Electric reconnaissance surveys were carried out in the Te Aroha mining area and peat deposits. Seismic experiments were undertaken in the Hawke's Bay area. The gravitational survey was extended, and revealed major structural features of the North Island.

Preliminary investigations were carried out on the geological crustal structure of the North Island. Using obsolete depth charges exploded near Ponui Island, the seismic tremors created by this explosion were recorded as far away as Cambridge.

Investigation of the dam sites of Aratiatia and Pararíki and of problems arising from the Geological Survey investigation of the Huntly coal basin have been commenced. Seismic tests in this area indicate that it will be possible to give detailed information on questions arising from underground and opencast mining.

A seismic survey was carried out for Ministry of Works in the Lyall Bay area in connection with the intended extension of Rongotai Aerodrome. The depth of greywacke rock was determined. In co-operation with Auckland Industrial Development Laboratories the Survey made instruments available and undertook technical control on problems of vibrations arising from quarry blasting.

Assistance was given to the State Forest Service in drilling for water on the Kaingaroa Plains and Minginui area, and for steam in the Rotorua area.

GEOPHYSICAL OBSERVATORY

Director: Mr. J. W. Beagley

During the year certain activities formerly undertaken by the Geophysical Observatory became the responsibility of other sections of the Geophysics Division, leaving this Branch free to develop its upper atmospheric research programmes.

Terrestrial Magnetism.—The observation of magnetic and solar phenomena has continued at Apia throughout the year, and at Amberley until September, when it was taken over by the Magnetic Survey. Publication of the data for New Zealand and overseas institutions has been maintained at the Observatory.

Ionosphere.—The ionospheric stations at Lincoln, Campbell Island, and Rarotonga have been maintained and the data obtained analysed for the ionospheric prediction centres at London, Washington, and Melbourne.

Early in the year a complete overhaul of the Rarotonga equipment was carried out. An emergency power supply unit had to be developed urgently for the Campbell Island station, and was installed early in November.

The basic design of the multifrequency h't recorder was completed and the detailed work commenced.

Designs of a modified aerial system were obtained, and plans made, for changing over to the new system at all stations in view of the deteriorating conditions of aerials at Lincoln and Campbell Island.

During the solar eclipse, March 7d. G.M.T., additional recordings were taken by the Lincoln ionosonde. Changes in ionization in the E and F_2 layers of the ionosphere were observed during the eclipse.

Cosmic Radiation.—The Carnegie Institution of Washington Compton-Bennett ionization chamber operated continuously, and results were sent regularly to the Carnegie Institution of Washington and other interested organizations.

The MU2 equipment operated during the year, but the continuity of recording was affected by development of many faults yet to be rectified. A vertical incidence cosmic-ray recorder using spare MU2 trays was built for use in Samoa and is ready for installation.

A wide-angle recorder for measuring cosmic-ray showers was built. Because of staff shortage, further work on this subject and the examination of nuclear research plates has been discontinued.

Other Activities.—Tidal recording and measurement of sea densities and temperatures was continued. Data have been forwarded regularly to the United States Coast and Geodetic Survey and the Oceanographic Observatory, Wellington.

Seismological bulletins have been prepared quarterly, while air letters of preliminary earthquake readings have been despatched to New Zealand, American, and Australian observatories. The practice of advising the United States Coast and Geodetic Survey of strongly recorded shocks has been continued. A double magnification mirror was attached to the Wood-Anderson seismograph in September.

Earth-current recordings on east–west and north–south lines at Amberley were commenced.

Until September climatological observations in Christchurch were continued, weather summaries were supplied to the Meteorological Office, Wellington, and equipment (thermometers, &c.) tested.

During the year visits were made by the Director to Rarotonga Ionosphere Station and to Apia Sub-observatory. The Director also spent some weeks in visiting Australia at institutions and universities conducting ionospheric and cosmic-ray research as well as other geophysical activities. A study was made of methods used in Australia and problems being tackled, and from the discussions closer liaison between workers in the same fields in New Zealand and Australia is anticipated.

MAGNETIC SURVEY

Director: Mr. H. F. Baird

From September, Magnetic Survey resumed responsibility for magnetic measurements and analysis at Amberley Station and nominally became responsible for the technical direction of magnetic observations at Apia Observatory as well. The latter change was spread over some months by arrangement with the Geophysical Observatory. The responsibility for interpretation of earthquake records was passed to the Seismological Observatory. Climatological observations reverted to Magnetic Survey, who in 1902 initiated them. As the branch has to prepare navigation charts over most of the Pacific to the south and west of Honolulu—the nearest magnetic observatory beyond its charting territory—this consolidation of magnetic coverage was timely, as it brought unified control in getting needed observations in a large area.

Magnetographs.—At Amberley the Eschenhagen, Adie, and La Cour magnetographs gave continuous photographic traces of magnetic horizontal and vertical force as well as of declination or direction of the compass. Every three hours the range of magnetic activity was measured in what are called K-indices. These were sent air mail frequently to international headquarters for collation

with those from other countries. They have bearing on investigations into radio-communication conditions and are supplied to local and other experts in that field.

Field Programmes.—Magnetic stations were reoccupied in several parts of the South Island in order to check the gradual rate of change which arises from causes yet unknown. New stations were established to improve magnetic coverage over undisturbed basement rocks and also to serve as ground checks for air-borne magnetometer surveys. Charting was thereby made still more reliable. Arrangements were made with Civil Aviation Branch for an observer to go on one of their regular check flights to several Pacific islands. Over all this area, except at Apia, modern knowledge for air navigation chart requirements is lacking and urgently required. By permission of Marine Superintendent, Union Steam Ship Co., a start was made to study azimuth logs of their trans-Pacific ships. These may show enough consistent data for best routing of oceanic aeromagnetic flights.

The Quality of the Instruments.—Once again comparison of Amberley records was made with instruments sent specially from international headquarters in Denmark. Results appear satisfactory. A check on the orientation of magnets at Amberley proved highly satisfactory. Ten new QHM instruments for New Zealand and Pacific needs were recently received from Denmark. They give both reliable declination and horizontal values in about ten minutes of time.

Aeromagnetic Work.—A close grid was completed over the geothermal area and necessary correlative flights were made on longer traverses. Magnetic properties arising from geological structures between White Island and Akaroa and as far out as the Mernoo Bank have been mutually tied into New Zealand's magnetic base values at Amberley. In most cases the final relative accuracy from flights is rather better than current land-based methods would give. Areas of marked magnetic disturbance were found in several new places, such as over Cook Strait. The sources and extents of errors were traced to several instrumental factors and, where possible, were eliminated or reduced. Thirty-three survey flights were made and some eight thousand miles were covered up to the last flight on 9 August 1951.

Charts and Publications.—Special charts were prepared for Navy and Civil Aviation Branch for local and Pacific navigation needs, and all new field results were communicated to British, United States of America, and international hydrographers for world charts. The "N.Z. Pilot" was kept up to date. Priority is being given in the preparation of iso-magnetic charts relating aeromagnetic observations with geological features in the area where economic use of geothermal steam is under test. A paper by A. L. Cullington, "The Magnetic Secular Variation in New Zealand," was published in Vol. 33, No. 5B, J.S.T. Other papers and reports are in preparation.

Climatological Work.—Observations were continued, since there is a sustained local demand for this information.

OCEANOGRAPHIC OBSERVATORY

Director: Mr. W. M. Jones

Defence Science.—A considerable portion of the year's activity has been on oceanographic matters relevant to problems of defence science.

Wave Studies.—Analysis of wave records obtained at Greymouth using the Admiralty Wave-recorder, together with meteorological data, has shown that the distance of origin of some wave systems can be reliably deduced from the records, and has supplied useful material for studies of wave propagation and of methods of predicting swell. Recording has been discontinued for the present owing to trouble with the sea unit.

Study of daily reports of sea conditions to the Meteorological Office in 1951 from twelve selected localities around the coast has enabled a comparison of general roughness, and of the times of year when maximum or minimum average roughness occurred. A similar study is being made for 1952.

Some aspects of wave action were investigated in relation to the design of the seawall contemplated by the Ministry of Works for the aerodrome extension at Rongotai.

Sea Temperatures and Salinities.—The valuable co-operation of naval and merchant vessels, and of the Meteorological Office, in supplying data on sea temperatures and samples for salinity analysis has continued. Several surface recording thermographs have been operating, and some hundreds of bathythermograph records obtained. Some nine hundred analyses of samples for salinity have been made by the Dominion Laboratory. Interesting features of both coastal and oceanic hydrology, which have important bearings on marine life, are becoming apparent, and an account of results is in preparation.

Apparatus has been assembled for measurement of salinity by electrical conductivity, and of sea temperatures by a thermistor method.

Currents.—The shore-electrode method of indicating off-shore currents was tried at Kaikoura; semi-diurnal oscillations were not prominent, as was found also in direct measurements by "Lachlan" at a point twenty miles off the Peninsula, where the current was largely unidirectional, with a superposed diurnal oscillation.

Apparatus for the Von Arx method of measuring currents in deep water by towed electrodes has been assembled, and given a preliminary trial on "Lachlan" in Cook Strait.

Miscellaneous.—In a study of possible variations of sea-level, the daily barometric pressures on some Pacific islands, as issued in Meteorological Office reports, were put through the frequency analyser, and an occasional forty-day oscillation, with amplitudes of a few millibars, was detected at Apia, Rarotonga, and Manihiki.

An increasing information service to other Departments and to the general public is being given on oceanographic questions.

SEISMOLOGICAL OBSERVATORY

Director: Mr. R. C. Hayes

Seismology

Seismic Activity.—The outstanding seismic event in 1951 was the severe disturbance in the Cheviot region, which commenced on 11 January. The initial shock reached intensity M–M 7–8 in the epicentral area, causing considerable damage. It was felt from Cook Strait to Hokitika and South Canterbury. The instrumental magnitude was 5·6. Several strong aftershocks occurred, in addition to a large number of minor ones. One aftershock on 18 January reached intensity M–M 6–7 at Cheviot. This activity began to decline towards the end of January, and during the remainder of the year seismic activity in general was more normal.

On 10 February there was an outbreak of activity off the coast of southern Hawke's Bay. The initial shock of magnitude $6\frac{1}{4}$–$6\frac{1}{2}$ was felt widely in the North Island, the maximum intensity reported being M–M 6.

A shock of magnitude near 7 and depth 370 km. occurred on 28 March beneath the White Island region. It was felt extensively in the central and eastern parts of the North Island south to Cook Strait region.

On 23 April a shock of magnitude 6¾ occurred in the East Cape Peninsula, and on 24 June one of magnitude 6¼ in the region between Hawke's Bay and Ohakune. Both these shocks were widely felt, with maximum intensity near 7, causing some damage in the epicentral regions.

During July and August there was some seismic activity in the far South. The principal shock occurred on 7 July with epicentre in the Milford Sound region. It was felt throughout Otago and Southland and in southern Westland, with maximum intensity M–M 5.

A considerable number of shocks were reported felt during October, the main activity being centred in the Takaka region. These shocks were perceptible at various places from Taranaki to Hokitika, the maximum reported intensity being M–M 5–6.

In December there was an outbreak of activity north of Taranaki, with two shocks reaching intensity M–M 5 on 12th and 14th and a considerable number of minor ones.

During the period April–May there was some concentrated local activity of moderate intensity in the region west and north-west of Lake Taupo and in the Cape Campbell area.

In all, 226 earthquakes were reported felt in New Zealand during the year, 71 in the North Island and 165 in the South Island. Ten of these shocks were felt in some part of both Islands.

Seismograph Stations.—All existing seismograph stations were operating continuously throughout the year, except the Jaggar at Takaka, which was discontinued on 31 March in view of the new Wood-Anderson installation at Cobb only a few miles distant. The Wood-Anderson seismograph originally at Arapuni was installed at Karapiro on 8 June.

A large amount of preliminary work has been done, related mainly to the selection of the best type of equipment and the most suitable site for a first-class teleseismic station. Useful information was collected from authorities overseas, and a Wilmore seismograph has been ordered from England for site-testing.

Field-work.—Two members of the staff took part in the Division's seismic experiments in the Firth of Thames region, and they investigated possible sites for similar experiments in the South Island.

Some observations of microseismic activity in parts of the Wellington region were carried out with portable equipment.

Engineering Seismology.—Earthquake records from the Wenner accelerometer were analysed by the Dominion Physical Laboratory. The Observatory is represented on the Advisory Committee on Engineering Seismology.

Research.—Research was on the seismology of the Tonga-Kermadec region and its relation to New Zealand; some New Zealand aftershock sequences; microseisms at New Zealand seismograph stations; and amplitude ratio of P and PP seismic waves and its relation to crustal structure. In addition, a considerable amount of non-routine technical work, not classified as pure research, was carried out in connection with seismograph-site testing and the teleseismic station project.

Publications.—Monthly provisional earthquake bulletins were published regularly, and quarterly reports (E-series) for the period 1949 April–September were published. Apart from routine bulletins, four papers were published.

Time Service

Time Signals.—The time service was maintained. The average error of the ZLW radio signals was between 0·02 seconds and 0·03 seconds, and the maximum error 0·3 seconds. The signals failed completely on one occasion and partially on three occasions. All failures were due to causes outside the Observatory.

By arrangement with the New Zealand Broadcasting Service, a new time-signal schedule for broadcasting stations came into operation on 14 May.

Public Clocks.—The Government Buildings clock was checked daily and regulated when necessary. The maximum errors observed during the year were 25 seconds fast and 25 seconds slow.

The synchronous electric clock was interrupted by weekly power cuts. The maximum observed errors during the year were 16 seconds fast and 12 seconds slow.

GRASSLANDS DIVISION

Director: Dr. J. Melville

There have been major changes in the organization of Grasslands Division. Mr. E. Bruce Levy retired in December 1951 after forty years' service to agriculture and agricultural research and after gaining an international reputation as one of the world's leading pasture ecologists. He was succeeded by Dr. J. Melville, formerly Director of Plant Chemistry Laboratory. The Laboratory is now incorporated with Grasslands Division, whose activities have been regrouped into three major sections—Plant Breeding, Plant Chemistry, and Pasture Ecology.

SHORT-ROTATION RYEGRASS

Short-rotation (S/R) rye-grass has been available in commercial quantities since 1947, and the experience of the intervening five years makes possible an assessment of its value and potentialities. It was produced to fill the gap between perennial and Italian rye-grasses, which, up till that time, was covered only by false perennial types. The specifications called for a high-production grass that would combine a life of four or five years with as much as possible of the leafiness, palatability, and early spring growth of Italian ryegrass. It was hoped that the strain would be particularly suitable for those districts where a system of short-rotation grassland farming is practised.

To this end a breeding programme was begun in 1937 with the controlled hybridization of selected Italian and perennial rye-grass plants, these species being completely inter-fertile. As was to be expected of plant material of hybrid origin, there were wide differences between progenies obtained from different crosses, and between the progenies of any one hybrid. In order to reduce this wide variation and to fix the type within reasonable limits, the system of "maternal line breeding" was adopted, and after some five years a line consisting of fairly uniform plants of the desired type was obtained. Its variability was greater than that of pedigree perennial or pedigree Italian rye-grass, but it was sufficiently uniform to retain its type through the requisite number of generations for seed certification purposes.

The new S/R rye-grass was well received by farmers, and for the first two or three years after its release by the Department of Agriculture the demand for seed was far greater than the supply. This situation was remedied at the 1948 harvest, and the demand since that date has been regulated more by price than by any other factor.

Unfortunately the assessment of a new strain or species of pasture plant is not easy. There are, however, two criteria immediately available—viz., quantity and value of harvested and exported seed. During the three years 1948 to 1950, between 2,200,000 lb. and 3,000,000 lb. of seeds, moderately valued at £150,000, was harvested annually. The value of exported seed rose from £13,000 in 1948 to nearly £60,000 in 1950, an illuminating commentary on the versatility of the new strain in meeting the requirements of farmers in quite different environments.

Short-rotation rye-grass, however, was bred not for export, but for sowing in New Zealand pastures, and a much more important assessment would lie in its value in increasing pasture production. This is something to which no accurate monetary value can be attached, owing to the unsolved difficulty of measuring any increase in pasture production resulting from one particular factor in the whole composite of factors involved. Nevertheless, from the reports of farmers and extension officers, and from our own detailed observations over a wide range of habitats, a reasonably accurate account can be given of the present position.

Firstly, it has fulfilled the purpose for which it was bred—viz., catering for the three- to five-year pasture and acting as a vigorous feed-producer in the early years of a permanent pasture. Again and again the comment is heard that in speed of establishment, palatability, and early spring growth it is practically the equivalent of Italian, while its permanence is much greater.

Secondly, marked improvement in permanence has been achieved through selection and breeding since 1947, and it can reasonably be claimed that, given appropriate grazing management, S/R is virtually perennial under a wide range of soil and climatic conditions. Concurrently with this improvement in permanence has been a marked increase in uniformity.

Thirdly, the characteristics which make S/R rye-grass so suitable for short-term pastures in the South Island have resulted in its widespread use in the dairying and fat-lamb pastures in the North Island. Its ability to grow during late winter and early spring is most valuable during the first few weeks of the cows' lactation period and for ewes just prior to lambing. It is therefore making a valuable contribution to the feed-supply at a critical period of the year.

Perhaps even more important than this characteristic is its high palatability in comparison with perennial rye-grass, since it has resulted in entirely new conceptions of pasture utilization and management. It has long been recognized that perennial rye-grass rapidly loses palatability when allowed to get beyond the 2 inch stage of growth. This is particularly noticeable when the plant would normally be producing flower and seed heads; to retain palatability at that stage requires intensive grazing. This has a number of adverse results. Total production declines, due not only to the poor performance of rye-grass itself, but also to the check suffered by the clovers and by other grass species, such as cocksfoot, which rapidly disappear under close grazing. This in turn may lead to invasion by undesirable species. S/R rye-grass, on the other hand, inherits from its Italian parent the property of high palatability at virtually all stages of growth. It has frequently been observed that S/R rye-grass is eagerly accepted by stock at any stage up to the production of fully formed seed head—*i.e.*, in pastures up to 14 inches in height. It can readily be seen that this property is capable of wide exploitation, and two examples may be cited. The first relates to the problem of bloat, the incidence of which appears to be substantially reduced by intensive break feeding of S/R-white-clover pastures at about the 10 in. stage or higher. The herbage from such pastures contains a high proportion of stem tissue which, by the break feeding method, is consumed along with the leaves. Cows require no encouragement to eat to appetite on such pastures when S/R rye-grass is dominant; where perennial rye-grass is the dominant species they refuse to eat the fibrous stem tissue. By the use of S/R-dominant pastures a number of farmers for whom bloat represented the major source of worry have been successful in reducing its incidence and severity without loss of production.

The second example deals with fat-lamb production. By applying pilot-scale results obtained on this area, a Kairanga farmer has had spectacular success in raising and fattening lambs on pastures which are dominantly S/R rye-grass with white and red clovers as sub-dominants. These pastures, like those mentioned above, are fed off at a stage of growth far more advanced than is usual or than would be possible where perennial rye-grass is the dominant species. Moreover, this type of management favours red-clover growth during the summer period. The consequence is that carrying-capacity has been greatly increased, while stock thrift has been more than maintained. Parallel results, although only on the pilot scale, have been achieved at our Gore substation under the very different climatic conditions of Southland.

In view of these examples it is not surprising that a number of farmers are changing their seeds mixture and grazing management with the aim of making S/R rye-grass the dominant species in their pastures. This change, however, brings with it new problems which are now being investigated. For example, rates of seeding for such pastures are being studied, since the rapid establishment of S/R rye-grass causes excessive shading of the less vigorous clovers, which still remain the most important components in the sward. On well-prepared seed-beds, rates as low as 10 lb. per acre have been entirely successful, even though the production of herbage over the first six months is less than that at higher rates. Better sowing methods—*e.g.,* by means of the roller drill—will undoubtedly lead to more certain strike of seed at considerably lower sowing rates than are now generally recommended.

Low seeding rates, however, pose problems in relation to weed control, which in the past has been achieved on North Island farms by heavy sowings. Further work is necessary before a satisfactory balance between speed of establishment for the pasture as a whole, clover growth, and control of weed growth is achieved. One point, however, is clear: the necessity remains for early control of young S/R rye-grass growth in order to give the clovers good conditions for early establishment, and the problems inherent in maintaining desirable grass-clover ratios from emergence to maturity are being tackled in a variety of ways.

It must be emphasized that these investigations, which are designed to give information that can be directly applied in farming practice, are based on certain fundamental characters of the S/R rye-grass plant and of the other plants with which it must compete in pasture associations. Results of general applicability will be obtained only when these characters, among which may be listed nutritional requirements, reaction to light and shade (as shown by leaf production, tillering, &c.), and reaction to temperature are fully known. This work is being done as rapidly as possible, the limiting factor being shortage of technical staff.

The whole project is a most interesting study in the integration of a number of scientific disciplines. The problem was observed and defined by the pasture ecologist, who handed to the plant breeder the specifications on which a wide breeding programme should be based. The plant breeder handed back to the ecologist a plant fulfilling those specifications, but continued to make substantial improvements in later models. The ecologist then tried the plant under the widest possible variety of climatic, soil, and management conditions so that farmers might be informed of its potentialities in their particular individual farming systems. But to accomplish that he called on the plant physiologist and plant chemist for more exact information on the reactions of the strain to different environmental factors and on its metabolism.

PLANT BREEDING

Further breeding-work is continuing with rye-grass, cocksfoot, timothy, white clover, and red clover. In long-rotation rye-grass, progeny from crosses are being studied for the selection of desirable or "elite" plants to form the parent material for the new strain.

Work on the variation in *Lotus uliginosus* and *L. corniculatus* is being carried on. In the hope of making these crosses more readily, seeds and seedlings of *L. uliginosus* were treated with colchicine to double the chromosome number.

Further investigation is under way on the possibility of producing a strain of perennial rye-grass resistant to blind-seed disease. Work on artificial inoculation with the organism has confirmed that highest infection occurs when the florets are open.

STRAIN ECOLOGY

Yield Trials.—Measurement trials at Palmerston North, Lincoln, and Gore are recording the superiority of this station's nucleus selections over non-pedigree seeds and selections from plant-breeding stations overseas. The species under trial are perennial rye-grass, Italian rye-grass, short-rotation rye-grass, cocksfoot, Montgomery red clover, cow-grass, and white clover.

Technique for Strains Measurement.—The original experiment, comparing the yields of rye-grass strains under a system of mowing with proportional return of a compound mixture of artificial fertilizers, as against stock-grazing followed by a proportional return of dung and urine, has been concluded.

Seed Certification and Nucleus-seed Production.—Plot tests totalling approximately nine thousand have been completed, as in former years. The usual quantities of nucleus seeds have been distributed to the Crop Research Division and Department of Agriculture for further increase.

An endeavour is being made to find a more rapid test for certified strains of Montgomery red clover and cow-grass.

PLANT CHEMISTRY

Nitrogen Metabolism of Pasture Plants.—Amino acids are the building-blocks out of which proteins are constructed in all living tissue and both quantitatively and qualitatively are the most important nitrogenous constituents of leaf sap. Complete analyses by microbiological methods have been achieved for the first time, and the distribution pattern at different stages of growth and under different manurial systems has been determined. Similarly, the peptide fraction (which represents the intermediate stage between amino acids and proteins) has been isolated and analysed. The most interesting feature is that distribution patterns vary markedly between the free amino acid, the peptide, and the protein fractions.

Of great theoretical interest are the analyses on lupin nodules. Free amino acids and peptides are present in high concentration, while urea occurs to a greater degree than in any other plant tissue examined.

Protein Studies.—Work has been commenced on the proteins of the white-clover plant by methods applied in the past only to animal tissues. This has been made possible by the installation of an ultracentrifuge (designed and fabricated by Dominion Physical Laboratory) and an electrophoresis apparatus.

Studies on Herbivorous Urine.—Both sheep and cow urines have been analysed for free and combined amino acids. Unlike the urine from all other species, virtually only one amino acid, glycine, is present.

Further work has been carried out on the inhibiting substances present in herbivorous urine. Seedling clover roots are particularly sensitive and show

retardation at high dilutions either of urine itself or of ether extracts of urine. By chromatographic procedures considerable purification of the inhibitory fraction has been achieved, while the residue contains substances which mildly stimulate root growth. The evidence suggests that the inhibitor is an inhibitor-auxin complex or an anti-auxin.

Most if not all weed seeds in soil are killed by wetting with cow urine. Death probably results from a combination of factors such as ammonia content, high alkalinity, high salt concentration, and the presence of inhibitors. Grasses are much less susceptible to the inhibitor than clovers and the majority of weeds examined. Once grasses have emerged satisfactorily, urine stimulates growth through high nitrogen and potash supplies, and shading of other species may ultimately result. However, the evidence at the present time strongly points to grass dominance within the urine patch and within night paddocks on dairy-farms being due to direct suppression of clovers and weeds by urine inhibitors.

Ruminant Digestion.—The initial difficulties experienced in keeping fistulated sheep in healthy condition have been overcome. Techniques for the isolation of various bacteria important in rumen digestion have been studied. Methane bacteria which have not before been isolated from the rumen have been obtained in almost pure culture. The main end-products of the digestion of carbohydrate materials in the rumen are the volatile fatty acids, acetic, propionic, and butyric. A new method for their estimation employing liquid-gas chromatography is being set up to handle analyses for these important constituents on a routine basis. Work has also been started on the organic acids (malic, citric, tartaric, &c.) present in pasture plants with a view to determining their importance in ruminant nutrition.

Regeneration of Peroxidase in Blanched Tissues.—Since peroxidase is one of the most heat-stable enzymes in plant tissues, its inactivation has been used as a criterion for the adequacy of blanching in preparing vegetables for freezing or dehydrating. It has been noted that with certain vegetables (notably swedes) there is a regeneration of peroxidase activity after apparently adequate blanching. Evidence has been accumulated to show that the inactivation-regeneration phenomenon is not due to a reversible splitting of the enzyme into protein and prosthetic group as occurs when peroxidase is treated with cold acetone-hydrochloric acid.

Seed Research.—Further progress has been made in the study of the anatomy and physiology of the seed coat of clovers, and the factors leading to the "hard seed" condition in this and similar species have been largely elucidated.

The relationship between atmospheric humidity and moisture content of stored seeds is being determined preparatory to an investigation of the influence of these factors on the preservation of vitality in the seeds. The deterioration of rye-grass seed under adverse storage conditions is being studied, the embryo staining method and germination tests being employed to indicate loss of vitality.

Seedling Growth of Pasture Plants.—Under conditions of abundant nutrition, seedlings of several species of pasture plants have been found to take up mineral nutrients to high levels, particularly in the roots. Together with their capacity for very rapid increase in weight, this shows the need for an ample supply of nutrients within reach of the young roots if vigorous early growth is to be maintained. In clovers there is a need for some combined nitrogen during early growth before nodulation has reached the effective stage. This is somewhat more apparent in subterranean than in white clover and appears to be influenced by environmental conditions.

PASTURE ECOLOGY

In addition to the studies in pasture management and utilization dealt with under "Short-rotation Rye-grass," the following investigations have been made.

Influence of Clovers and Fertilizers on Pasture Growth and Composition.—With the sowing to rape and maize of the mowing section of the trial, this investigation has been brought to a close, and is being written up for publication. With the similar studies at Lincoln and Gore it represents the most complete study yet made of the various factors leading to high pasture production and of the level of fertility built up under widely varying pasture associations as determined by the yield of subsequent arable crops.

Rate of Sowing.—At constant rates of red and white clover, the amounts of S/R and perennial rye-grass have been varied from 15 lb. to 40 lb., both alone and in combination. Whereas with pure perennial the higher seeding rate appears to be the more effective, the mixtures containing S/R were more successful at the lower levels. In the latter case the low-rate pastures were outyielded during the first three months of the trial, but their better subsequent clover growth gave more productive and better balanced pastures at the six-month stage.

Hill-country-pasture Improvement.—At the Te Awa Experimental Area pasture cover and production has continued to improve on the trials that have been oversown, top-dressed, and adequately managed. Further information has been gained on the comparative merits of set stocking and rotational grazing on both shady and sunny slopes.

Close grazing both before and after oversowing with clovers appears to be the most satisfactory method for good establishment. The chief predators of clover seedlings appear to be *Porina* caterpillars on Te Awa and slugs in the Gisborne district.

Greenkeeping Research.—The Hokowhitu area, which has for twenty years provided the basic information for satisfactory turf maintenance, is being wound up, and a fresh series of trials designed to answer the problems that still face greenkeepers is being established on the main area.

SUBSTATIONS

Gore.—This station has now completed its establishment phase with the completion of the bulk of single plant strain and species comparisons. Investigations planned and in progress are designed to answer specific problems of the Southland Province, with emphasis on lamb-fattening trials, simple species mixtures (*e.g.*, timothy - white clover, cocksfoot - white clover, and meadow fescue - white clover in comparison with rye-grass - white clover), and timothy and cocksfoot seed production.

Lincoln.—The trial in which different farming systems are being compared on pilot-scale farmlets provides valuable information on means to overcome shortages of feed due either to summer drought or winter cold. Cocksfoot and lucerne drilled separately in rows 3 inches apart appears most promising for dry conditions.

RESEARCH EXTENSION

In addition to broadcast lectures and talks to farming groups, a total of 480 New Zealand and 73 overseas visitors were shown over the station.

PUBLICATIONS

Members of the staff have submitted for publication thirty-three papers, most of which have already been published.

INFORMATION BUREAU

Officer in Charge: Mr. N. A. Marris

PUBLICATIONS

Journal of Science and Technology.—The arrears in the publication of the *Journal* were overtaken in May 1951 and prompt publication has since been maintained. The standard required for the acceptance of articles has been raised, and the present policy is, in general, to accept articles embodying the results of original significant research work. In view of the increased cost of publication, it is proposed to raise the subscription as from June 1953. The quantity of manuscripts received during the year has again shown an increase. As in previous years, more material was received for publication in the Agricultural Research Section than for the General Research Section. With a view to improving the standard of papers submitted and thus reducing the amount of editorial work, the various Divisions of the Department are being encouraged to set up their own editorial committees. Tentative standards to be followed in preparing material for publication were drawn up and issued by the editorial staff during the year.

Bulletins.—Bulletins published during the year have included: D.S.I.R. 101, "A Revised List of Plant Diseases Recorded in New Zealand," by R. M. Brien and Joan M. Dingley; D.S.I.R. 103, "New Zealand - American Fiordland Expedition," compiled by A. L. Poole; D.S.I.R. 104, "A Statistical Study of Linen Flax Crop Records," by G. M. Wright; Geological Bulletin 48, "Geology of Bruce Bay - Haast River, South Westland," by H. W. Wellman; Geological Memoir 8, "The Geology of Rangitikei Valley," by M. T. Te Punga; Paleontological Bulletin 18, "Tertiary and Recent Marine Ostracoda of New Zealand," by N. de B. Hornibrook; Seismological Report E. 117; Christchurch Magnetic Observatory Reports, 1937–39, 1940–42, and 1943–45; Amberley Magnetic Results, 1946–48; Soil Bureau Bulletin 6, "Soils and Their Utilization, Green Island-Kaitangata District," by A. C. S. Wright *et al;* Soil Bureau Bulletin 7, "Soils of South-west Fiordland," by A. C. S. Wright and R. B. Miller; "Canterbury Project—Radio-meteorological Investigations in the South Island of New Zealand"; and Cape Expedition Series, Bulletins No. 5 and No. 7.

CENTRAL LIBRARY

An important feature of the year's work was the reorganization and consolidation of the Central Library in new and better-appointed premises. This has resulted in appreciably increased services to Branches of the Department and other users of the Library.

The contribution of the Department's libraries to its research workers is being limited by restriction on the purchase of essential publications. In research laboratories books are regarded as tools, and controls relating to their purchase should not be more restrictive than those governing the purchase of equipment. The present position differs from this in that each branch has a small inflexible amount included in the estimates of another Government Department, and this amount is partly controlled by that Department.

Cyclostyled lists showing certain categories of publications held in departmental libraries have been circulated to Branches; because of this, some diminution of the borrowing and lending, as compared with the previous year, has taken place.

A trained librarian was appointed as District Librarian, Christchurch, and has given valuable assistance to officers in charge of small branch libraries in the Christchurch area.

TECHNICAL INFORMATION SECTION

Advisory Service.—This Section dealt with 627 major inquiries during the year. Approximately half of these were from manufacturers, and one-third from Government Departments and local authorities. Some 80 letters of appreciation showed that the service is valued in industrial and official circles. The Technical Information Officer keeps in close touch with the professional staff of the Department and with the Scientific Liaison Officers in London, Washington, and Melbourne. Efforts were continued to extend liaison with various information agencies, the technical staffs of private firms, and other organizations. Most major inquiries have been answered by individual letter, but frequently recurring questions are answered by circular prepared by various branches and by the Technical Information Officer.

The financial benefit to industry from the above advisory service is difficult to assess but is considerable; in one case, for instance, a saving of £15,000 resulted.

The *Industrial Bulletin* is published jointly by this Department and the Department of Industries and Commerce. Articles for inclusion have been received from the Department of Health, Department of Labour and Employment, and Marine Department. Our own Department's section of this bulletin has continued to specialize, in certain issues, in subjects of current importance—*e.g.*, in building, electroplating, food industry and trade, industrial health and safety, rodent control, &c. Requests for originals of abstracts published numbered 328.

Abstracts.—Approximately 300 abstracts of scientific and technological papers were prepared during the year; 266 of these were contributed to the *Industrial Bulletin*, some being made direct from articles in foreign languages.

Photo-copy Service.—Over 20,000 pages were copied to meet requests from departmental officers and others.

TRANSLATIONS SERVICE

During the year a full-time translator, qualified in science and with a good knowledge of several languages, was appointed to the staff. This service is proving of substantial benefit to the Department.

PUBLIC RELATIONS

Press Publicity.—The regular issue to the press of information on the work of the Department continued through frequent press releases to all newspapers, suitable magazines, &c., and through interviews and special articles. This form of publicity has been well received and good coverage obtained.

Departmental Handbook.—A publication summarizing the organization of the Department and the work carried out by the Branches is in the course of preparation. The object is to provide a handy reference book that will embody in a concise form much information that has previously been available only from separate sources.

General.—Individual broadcast talks and a series of talks by members of the staff were arranged through the New Zealand Broadcasting Service. The Film Section continued to make available scientific and industrial films to Branches and interested outside organizations. With the co-operation of the Dominion Physical Laboratory, an exhibit was provided at the Science Exhibition at Nelson in November. Other work on the dissemination of information within the Department and to the press has been through the examination and distribution of press clippings, the answering of inquiries, and the giving of advice on production of publications.

PHOTOGRAPHIC SECTION

In addition to the normal photographic work undertaken by this Section—*i.e.*, photo-copy work, preparation of lantern-slides, map reductions, gestefilms, &c.—the Section has acted in an advisory capacity to field officers. Colour slides taken at Ashburton, compared with similar photographs taken on previous occasions, show the progress in work relating to eradication of the grass-grub. A development during the year was the photographing for the Geological Survey of fossil shells, using the Leitz Panphot. The services of the Section are being used to an increasing extent by the Geophysics Division, recently, for example, in connection with seismological investigations. A large number of bathythermograph records were prepared for the Oceanographic Observatory.

OCCUPATIONAL PSYCHOLOGY RESEARCH SECTION

Officer in Charge: Mr. Dermot Straker

In the application of psychology and related sciences to occupational problems, this Section carries out research investigations into psychological aspects of employment in New Zealand, and maintains contact with psychological organizations overseas. Personnel advisory and serving work is undertaken on behalf of the Armed Forces. Information about modern trends and techniques in handling human employment problems is provided to industry and commerce.

RESEARCH

Labour Turnover.—Six-monthly returns published by the Department of Labour and Employment show percentage labour turnover rates for male and female employees in various occupational groups. The Industrial Psychology Advisory Committee drew attention to the fact that no information was available to show where the turnover was localized within these groups. In order to see what further information could usefully be brought to the attention of employers, a pilot survey was carried out in a small sample of firms in the Wellington and Hutt Valley area. Analysis of personnel records maintained by these firms indicated that in this sample a heavy wastage occurred during the first few weeks of employment, and that it was particularly severe among young female employees. A report of this survey will be available shortly. It is suggested that firms experiencing staffing difficulties should examine their own turnover data in order to determine the point of greatest wastage. If this proves to be in the early weeks of employment, greater attention to induction and training arrangements may help to ease the position.

Science Students.—As part of an examination of the Dominion's scientific man-power resources, a survey of all students registering for science degree courses in the University of New Zealand since 1930 was started in collaboration with the Applied Mathematics Laboratory. From this survey will be obtained information about the numbers majoring in each science, the combinations of sciences taken, the termination rates at various stages, the prognostic value of the University Entrance Scholarship Examination, and the drift between science and other faculties.

Armed Forces.—With the assistance of a psychologist from the New Zealand Defence Scientific Corps, several United Kingdom selection tests were adapted and standardized for use by the New Zealand Services. Arrangements have been made for investigation of the usefulness of these tests. Such assessment is necessarily a long-term matter, since it involves comparison between each recruit's test scores and criteria of his efficiency on training courses and later as a member of a Service unit.

SERVICE

Vocational Consultations.—Candidates for supervisory posts, for apprenticeships, or for internal promotions have been interviewed on behalf of industrial and commercial firms. A number of adults, including immigrants, have sought occupational advice from the Section. Several of these people were interested in personnel management, and those who had the necessary qualifications and experience were put in touch with organizations seeking personnel officers.

Armed Forces.—The Section continued to exercise technical supervision over the selection procedures used by the Navy and Air Force with national service candidates. A member was provided for Selection Boards dealing with cadet and cadet-midshipmen candidates for the Navy, and with aircrew, air-traffic control, and aircraft apprentice candidates for the Air Force. Most of the Air Force work was taken over during the latter part of the year by the newly appointed Staff Officer (Psychology). The Section is represented on a committee set up to co-ordinate personnel selection activities in the three Services.

LIAISON, EDUCATION, AND INFORMATION

Advice has been sought by industrial and commercial firms and by Government Departments on such matters as the design of staff records and report forms; the allocation and promotion of staff; the improvement of training arrangements; the approach to a reduction in staff wastage and absenteeism; the use of music in workplaces; and schemes of decoration for various types of workroom.

The Section's library has been in constant use by personnel officers from industry and the Services, and by University students. Lectures on psychological factors affecting working groups were given to courses for nurses and Health Inspectors, and a short broadcast talk was given on the programme of the Social Science Section at the Seventh Science Congress, to which three papers were contributed by the Section. During the long vacation two University students assisted with statistical analysis of selection test results, and one carried out the field-work for the labour turnover survey mentioned earlier.

Extension of these limited information and servicing facilities must depend on the availability of more trained staff.

PLANT DISEASES DIVISION

Director: Dr. G. H. Cunningham

The advisory service to the Department of Agriculture, other Government Departments, industry, and the public has been maintained. Over 1,100 plant specimens have been examined, and advice given on identity and control of pests or diseases present.

The Division has continued to assist with plant quarantine work, but proper quarantine is not possible till the required buildings for the quarantine station at Otara are authorized. Within the past two years three potentially dangerous plant pests have come in on plant material from overseas, and at least one of these seems to have become established. Twenty-five new fungous diseases have been observed in the Dominion during the past year.

The range of certified plant therapeutants has almost doubled during the past year. Two certification lists have been issued during this period.

Lucerne nodule culture sufficient to treat 370,560 lb. of seed was distributed to 2,626 farmers.

ENTOMOLOGICAL INVESTIGATIONS

Cold Sterilization of Citrus for Control of Fruit-fly.—Two further shipments of oranges from South Africa have confirmed that fruit-fly cannot survive the special low-temperature treatment.

Resistance of Plants to Insect Attack.—Further work has shown that certain swede varieties are resistant to attack by mealy cabbage aphid and suggests that resistance is influenced by climatic conditions.

House-fly Control.—Investigations have been continued with both space and residual sprays, and sufficient information has now been accumulated to introduce a certification scheme.

European Wasp.—Work on the biology of this insect has been continued. Field studies indicate that populations of the wasp are steadily decreasing.

A New Pest of Oak Trees.—A new leaf-mining pest has appeared in Hawke's Bay and Poverty Bay, primarily on oaks, but apparently spreading to other ornamental trees.

Russet on Lemon Fruits.—An investigation on russetting of lemons suggests that the damage may be caused by several species of thrips.

Recording of Mites on Apple Foliage.—A new technique for recording mite infestations has been developed, consisting of dipping leaves in a gum solution and then drying and pressing them.

Damage to Peaches at Warkworth.—Further work suggests that only a minor proportion of damage to fruits is caused by capsid-bugs. The possibility that the trouble is caused by a soil deficiency is now being investigated by the Fruit Research Station.

MYCOLOGICAL INVESTIGATIONS

Bean-rust.—This disease, which is new to New Zealand, was recorded from Auckland late in the 1950–51 season. This season it has been found only in late crops, and observations indicate that it appears too late in the season to be of serious economic importance.

Black Root-rot of Strawberries.—Black root-rot, which is caused by several species of fungi, results in losses comparable with those caused by red-core root-rot. Trials have shown that some varieties possess a considerable degree of resistance.

Blind-seed Disease of Rye-grass.—Work on the biology of the causal organism has been continued. Of the fungicides tested for control, Phygon shows most promise.

Verticillium-wilt.—The host-range of this disease in New Zealand now includes thirty-one different host species. Only two species, *Verticillium albo-atrum* and *V. dahliae,* are responsible for the disease.

Diseases of Linseed and Linen Flax.—Rust race studies have shown that twelve major and a number of minor races occur in New Zealand. Of seventy linseed varieties tested, nine were highly resistant. Resistance trials showed that no varieties were immune from pasmo, but that three were tolerant to the disease.

Field surveys indicated that volunteer linseed and linen flax plants and the wild species *Linum marginale* were important sources of infection for rust and that the last species was also an over-wintering host for pasmo and browning.

Diseases of Brassicas.—In dry-rot varietal resistance trials involving one hundred swede and turnip varieties, only one variety showed marked promise. Results of field trials in the South Island indicate that the major problems in brassica crops are dry-rot, club-root, and aphids.

Diseases of Peas.—Promising results on resistance to pea-wilt have been obtained with selections from Greenfeast, and it is hoped that a pea-wilt-resistant strain of Greenfeast will be ready for release by 1954. A further search for pea varieties resistant to foot-rot has yielded negative results. Field surveys confirm the previous conclusions that collar-rot and pea-wilt are the most important diseases of peas in the South Island.

Botrytis-rot on Tomatoes.—Observations suggest that early infection may spread from petals stuck to fruits through the use of fruit-setting hormones. Direct control with fungicides does not appear to be effective, but incorporation of a fungicide with the hormone has shown some promise.

Collar-rot of Apples.—Varietal resistance trials have shown that apple stocks differ widely in their susceptibility to collar-rot.

Phytophthora Collar-rot.—A species of *Phylophthora* causing collar-rot has been isolated from *Gerbera, Phebalium, Podylaria,* and *Erica.*

BACTERIOLOGICAL INVESTIGATIONS

Fireblight on Apples.—Investigations have been commenced to determine the possibility of controlling fireblight on apples by therapeutant applications.

Tomato-canker.—Further work has not confirmed last season's conclusion that copper sprays reduced infection. Promising results have been obtained, however, with Phygon XL.

Soft-rot of Swedes.—Experiments have shown that susceptibility of bulbs to bacterial soft-rot is markedly increased by prior infection with either turnip-mosaic or bacterial black-rot.

Walnut Blight.—In preliminary trials, therapeutants did not control this disease, but further work is being carried out on times of application.

Die-back of Stone-fruit Trees.—Work on this extremely serious disease of stone-fruit indicates that it is caused by a bacterium. Work is in progress to identify the causal organism and to ascertain whether control can be secured by use of therapeutants.

Clover Nodule Bacteria.—Trials have shown that the relative efficiency of nodule strains as determined by growth in nutrient solutions is maintained in soil. Growth of plants, in soils from areas not favourable for clover establishment, however, is unsatisfactory, irrespective of the nodule strain used. Sufficient information has been secured to allow field trials to be established in one locality.

Nodule Cultures for Establishment of Crotalaria.—Satisfactory nodule cultures have been developed to assist in establishment of extensive *Crotalaria* plantings at Aitutaki and Rarotonga, in the Cook Islands.

VIRUS INVESTIGATIONS

Occurrence of Tobacco-necrosis Virus in Lettuce.—Tobacco-necrosis virus, a new record for New Zealand, has been isolated from roots of lettuce. There appears to be some association between the occurrence of this virus in the roots and the presence of big-vein disease on the leaves.

Yellow-leaf of Phormium.—In this team project the virus nature of phormium yellow-leaf has been demonstrated and transmission secured by mechanical inoculation, root grafting, and insects.

Virus-free Potatoes.—The search for virus-free tubers of our main commercial potato varieties has been continued. Several hundred tubers have been tested, but no virus-free plants have yet been found.

Cauliflower-mosaic.—This virus, which is a new record for New Zealand, has been found to be widespread, and causes fairly heavy losses in market gardens.

Raspberry Virus Diseases.—Work on the indexing of raspberry stocks has been carried out in collaboration with the Department of Agriculture.

Chemotherapy of Viruses.—Further progress has been made in the investigation on control of plant viruses by chemical means; several substituted purines show considerable promise.

MICROBIOLOGICAL INVESTIGATIONS

Survey of Air-borne Mould Spores.—This survey, carried out at the request of the Medical Research Council, has been completed. In the course of the survey 44,597 mould colonies were examined. Although thirty-eight genera were indentified, 94 per cent of the colonies belonged to seven genera. " Spore showers " were found to occur frequently during the summer months.

Antibiotics.—Work with actinomycetes, five hundred of which have been isolated from local soils, showed that a number produced substances with antagonistic properties. One unidentified actinomycete possessing an interesting antibacterial spectrum has been studied in detail. Suitable fermentation media and methods have been developed for both shake and deep culture, and satisfactory conditions for pilot-plant production have been ascertained.

Industrial Problems.—Investigations have been carried out on the preservative treatment of tomato products and on the treatment of moulds and mould stains on upholstery.

TIMBER PRESERVATION INVESTIGATIONS

Toxicity of Timber Preservatives to Ambeodontus tristis.—Toxicity testing of timber preservatives has shown that the toxic loading of boric acid for *Ambeodontus* is intermediate between those for *Anobium* and *Lyctus*.

Preservative Treatment.—Study of the boric acid diffusion treatment has been extended to rimu. Sapwood of this timber in normal building sizes can readily be impregnated with boric acid by diffusion.

Preservative Treatment of Post Timber.—The applicability of sap stream methods (Boucherie process) to post-size logs of some locally grown species has been investigated. Results are not yet to hand.

PLANT THERAPEUTANT INVESTIGATIONS

Insecticide Studies.—Bio-assay or field trials were carried out to determine the efficacy of various therapeutants against mealy cabbage-aphid, green peach-aphid, and woolly-aphis. In general the most effective therapeutants were organic phosphorus compounds, BHC, and mixtures containing azobenzene and BHC, rotenone, or pyrethrin. In bio-assay tests, azobenzene smokes were highly effective against mites on grapes and phormium, while a large number of therapeutants were effective against tomato russet-mite. In field trials, parathion compounds and aramite were effective against red spider mite on apples and parathion against mite on plums.

Work on the biology and control of green vegetable bug has been continued. The insecticides shown to give the most effective control were HETP, DDT, and BHC. DDT or DDD in combination with lead arsenate gave better control of codling-moth of apples than any of these materials used separately. Combinations of DDT or DDD with lead arsenate gave better control of apple leaf-roller than any of these materials used separately. DDD was more effective than either DDT or lead arsenate.

HETP in combination with Lindane or DDT emulsions gave effective control of onion thrips. DDT aerosol formulations effectively controlled white-fly. In preliminary experiments on control of lucerne-flea, two insecticides—viz., lime-sulphur spray and BHC superphosphate dust—gave promising results. The insecticides DDT, DDD, and BHC all gave complete control of potato tuber-moth without leaving toxic residues. BHC, however, caused tainting.

Fungicide Studies.—In bio-assay tests and field trials, phenyl mercury salicylate formulated for application as an aerosol was highly effective in control of tomato leaf-mould. Phenyl mercury chloride, sulphurs, ferbam, and thiram gave equally effective control on black-spot and bitter-rot of apples. Ziram gave effective control of ripe-spot of apples. Phenyl mercury chloride gave effective control of apple-mildew. Dichloronapthoquinone and thiram gave promising results in control of brown-rot of peaches. In field trials to compare efficacy of seed dust treatments of onion smut with the standard formalin drip treatment, thiro dust applied at 50 per cent seed weight gave promising results.

Compatibility Trials.—Extensive tests to assess the phytocidal effect of spray combinations on apples, apricots, tomatoes, and potatoes have been carried out and charts published to guide growers when preparing spray mixtures.

PUBLICATIONS

During the year sixty-five articles, written by members of the staff, have appeared in seven different journals. A book on "Plant Virus Diseases in New Zealand" has been submitted for publication, and "A Supplement to a Revised List of Plant Diseases in New Zealand" has been prepared for publication, while "A List of Economic Pests in New Zealand" and "A Host List of Insects in New Zealand" are nearing completion.

SOIL BUREAU

Director: Dr. L. I. Grange

After 31 March 1952, Dr. L. I. Grange takes over the directorship of the Geological Survey, and Mr. N. H. Taylor succeeds him as Director of the Soil Bureau.

SOIL SURVEYS

Soil surveys have been carried out mainly in the Taupo, Gisborne, Foxton, and Central Otago districts.

For the Forest Service, 60,000 acres of afforested land were mapped on Kaingaroa Plains on either side of the junction of the Kaharoa and Taupo pumice showers. There appear to be broad correlations between soil type and tree growth, and these will be investigated in detail by the Forest Service. Similar work has been undertaken in North Auckland, where, in order to arrive at the best exotic species for particular sites, soils of selected areas of afforested land have been mapped in detail and observations on tree growth are in progress.

Soil maps of the Taupo district are being prepared for publication. The Soil Bureau is co-operating with other Government organizations in an attempt to overcome difficulties in establishing and maintaining pastures on the coarser-textured pumice soils near Taupo. A study of the soils, plants, and animals of the areas in forest, scrub, and tussock west of Lake Taupo is also being carried out in an endeavour to use ecological data to help plan the future development of the region.

A total of 39,500 acres has been surveyed in detail on the Gisborne Flats. About 13,400 acres are well drained and suitable for orchards and a variety of crops, while 18,600 acres have slow drainage and are used for fat-lamb production, dairying, and maize-growing.

At the request of the Department of Agriculture, a survey of the sand country north of Foxton was commenced. To date 21,100 acres have been mapped in detail. The coastal belt, where topsoils are thin or absent, consists of 5,000 acres of unconsolidated sand-dunes and 4,000 acres of associated wet flats. Development of the flats depends on control of sand drifts from adjacent dunes, of which less than half have been stabilized by planting. Inland, where topsoils are deep, there are 3,000 acres of sand dunes fixed by grass and 9,000 acres of flat land with moist subsoils. These flats grow good pastures and from them comes the bulk of the produce of the area. To maintain these pastures the water-table must be kept high, and accordingly any drainage scheme to remove surface water must be carefully planned.

In Manuherikia and Roxburgh basins a total of 38,000 acres has been surveyed in detail. Maps prepared show the suitability of the soils for orchards. At the request of the Lands Department a map showing distribution of salts and suitability of the soils for irrigation was made of part of the Pisa Flats.

A survey of Heathcote County (13,000 acres), one-third of which is flat land, has been completed.

Other detailed surveys of small areas, made at the request of various bodies, include Rotorua Borough, parts of Rangitikei Flats, areas in Hutt County, and several experimental stations.

Progress has been made with the general classification of South Island soils. The soil units have been defined, and land-use data tentatively correlated with them. Alternative methods of grouping the units are being examined. Additional field-work was carried out on parts of Wallace County, where development is at present limited by poor access and by lack of fertilizers and drainage.

The extended legend containing soil and agricultural information to accompany the North Island general soil maps is being printed.

During the year attention was concentrated on preparing past work for publication. Four bulletins were written and three others are near completion.

SOIL PHOSPHATES

Wherever difficulties exist with fertilizer-supplies, an understanding of natural soil fertility reserves is of prime importance. For this reason the phosphate fractions of Cook Islands soils are being investigated. In the laboratory the citric solubility of the phosphorus in some soils can be much enhanced by heating the soil at temperatures of 500°C. to 1,000°C. This increase was much greater in some cases than could be accounted for by the mineralization of the organic phosphorus.

Radiation injury to plants in pot experiments was reported from overseas when radioactive phosphorus was used as a tracer, even when smaller amounts than usual were applied. An experiment designed to test this conclusion indicates that, with the amounts used here, there is no significant damage to short-rotation rye-grass, and it appears that this applies to previous experiments made in this laboratory.

TRACE ELEMENTS

The survey of available copper in soils has been continued in co-operation with the Animal Research Division of the Department of Agriculture. A further 264 soils have been examined, mainly from North Auckland, Canterbury, and Gisborne. In general, soils from basic volcanic rocks contain the highest amounts of copper, and peats and leached soils derived from acid sediments the lowest.

Copper sulphate added as a dressing to soil increases available copper above the amounts added and in the soil. This appears to be due to the sterilizing of the soil by the added salt and the consequent release of copper fixed by soil organisms.

The Aspergillus method of estimating zinc has been tried experimentally with satisfactory results.

Analyses of cherry leaves from Alexandra and peach leaves from Cromwell showed low zinc content. Experiments were conducted with tree injections of solid trace element salts. The zinc and boron content of the leaves increased only when these salts were injected singly. On the other hand, an increase in manganese resulted whether the salt was injected alone or in combination with other salts.

Orange-trees at Aitutaki, Cook Islands, have responded to spray treatment with zinc salts. This correlates with the low zinc content of the leaves. Although the exchangeable soil potash was low, the potash content of the leaves was adequate.

Because of the shortage of sulphur, a survey of the sulphur requirements of New Zealand soils was begun.

SOIL ACIDIFICATION

The effects of acidifying soils with sulphur and sulphuric acid have been studied in co-operation with the Grasslands Division. Sulphuric acid acts a little more quickly than sulphur and, although the acidity approached a maximum within three months, losses of minerals in the drainage water continued for a year.

ANALYTICAL METHODS

A rapid method of determining organic carbon in soils has been examined and checked, and is in routine use. Methods of determining base exchange have been revised in order to take advantage of more rapid estimations now possible, particularly with the aid of the flame photometer.

A technique has been examined for analysing plant materials with the spectroscope. By this method, which appears satisfactory, it is hoped to expedite the minor element survey of New Zealand soils.

CLAY MINERALS

The determination of the nature of clay in different soils is well advanced. Correlations are emerging between the clay minerals present and the kind of rock from which the soil is formed, the stage to which the rock has been weathered, and the conditions of drainage.

SOIL MOISTURE

Investigations have been made of the water-holding capacity of Taupo pumice soils. The topsoils have some of the properties of peat soils—namely, abnormally high wilting-points, high saturation capacities, and low permeabilities to water when unsaturated. These properties tend to disappear after organic matter has been removed.

SOIL CORROSION

Approximately five hundred mild-steel corrosion test plates have been buried at twenty-five sites covering a wide range of soil conditions. These will be taken up and examined at intervals to obtain further information on the corrosiveness of New Zealand soils. Similar work is under way with fibrolite pipes.

SOIL MECHANICS

Testing of sites for heavy buildings and earthworks has continued to be the major work of this section. Proposed works investigated have included freezing-works at Patea, substations at Gisborne and Papanui, bridge sites at Lower Hutt and Wanganui, a spillway structure near Shannon, an earth dam in the Cobb Valley, drainage canals on the Hauraki Plains, harbour extensions at Opua, Auckland, and Bluff, an oil-tank installation at Point Howard, the Edgecumbe–Murupara Railway, and post-offices at Whangarei and South Dunedin.

Research is being undertaken on estuarine soils in different parts of the country in areas likely to be required for heavy buildings, and on volcanic ash deposits where abnormal physical properties affecting stability are related to the type of clay mineral present.

Laboratory equipment has been modified in accordance with standards recently adopted by leading laboratories in the United Kingdom.

PUBLICATIONS

Several articles were written for the *Journal of Agriculture* in co-operation with officers of the Department of Agriculture. Scientific papers published during the year or awaiting printing totalled twenty-eight.

WHEAT RESEARCH INSTITUTE

Director: Mr. E. W. Hullett

The Director spent almost six months on a tour of scientific and technical institutions and firms in England and on the Continent. The principal topics he studied were the storage and handling of wheat; developments in flourmilling and breadbaking; advances in understanding of the materials and processes used in breadmaking; and methods of teaching in baking-schools.

Bulk Handling of Wheat.—The traditional method of transporting and storing wheat in New Zealand has been based on the use of sacks. It seems likely that wheatgrowers will change to bulk handling and the millers will need to provide bulk storage facilities. This will increase the danger of loss of wheat because of high moisture content. High moisture content is more dangerous in bulked wheat than in sacked wheat unless special precautions are taken, because heat cannot be dissipated readily in bulk, and the wheat the millers receive may well be damp more often than it is now.

Activities at the Institute have two main aims: firstly, to draw attention to the need for farmers and millers to be more critical concerning the "condition" of wheat intended for bulk handling than they have been in the past; and secondly, to help in the selection or development of methods for storing wheat in bulk under New Zealand conditions.

During the 1952 harvest the Institute took part in a practical trial of bulk handling wheat from a farm to a mill, but owing to an exceptionally dry harvest the conditions it was desired to study did not arise.

During his recent visit to England the Director studied many bulk storage and drying installations with a view to their application in New Zealand.

Flour and Wheat Quality Testing.—Now that the Wheat-breeding Section of the Crop Research Division has produced wheat varieties with new high levels of baking quality and others with high yields, the testing of new hybrid lines for baking quality is more important than ever. Efforts are being made to find tests that can be applied at an earlier stage in the breeding process, and to widen the scope of the later tests. The Zeleny sedimentation test was applied to a

number of breeding samples of known quality and protein content, and the correlation between its results and protein content was good. It may serve as an early test.

A device designed by the British Baking Industries Research Association for measuring the stickiness of bread made from sprout-damaged flour was constructed, but was found to require too much time for routine use. It did, however, serve to show that the test bakers' judgment of stickiness is remarkably consistent, and that the need for an instrumental method is not great.

As a result of a request from bakers, the routine baking test has been altered to cause flours requiring more than 1 per cent of added sugar to fall outside the accepted grade.

Mixing Period of Doughs.—Preliminary trials with both strong and weak flours indicated that, although weak flours suffer more than strong flours do from extended mixing, the mixing time required to produce damage is longer than that used commercially. This means that mixing time is not critical under ordinary commercial conditions.

Extension Work.—Testing and advisory services for millers and bakers were carried on as in previous years.

Publications.—Members of the staff have contributed a paper to a scientific journal.

SCIENTIFIC LIAISON SERVICE

The Department's Scientific Liaison Officers in London, Washington, and Melbourne render a most valuable service by keeping the Department advised of the most recent and important scientific developments overseas.

London.—In addition to co-ordination with the High Commissioner's Office, the office forms part of the British Commonwealth Scientific Office, and the corresponding offices of the United Kingdom, Canada, Australia, South Africa, Rhodesia, and India are housed with the New Zealand office at Africa House.

Organizations with which the New Zealand Scientific Office is connected include the Commonwealth Agricultural Bureaux, Commonwealth Advisory Committee on Defence Science, Commonwealth Advisory Aeronautical Research Council, and the International Standards Organization.

The Scientific Adviser acts as a regular member of the New Zealand Joint Services Committee.

Other activities include assistance to New Zealand scientific personnel in the United Kingdom, recruitment, and the handling of inquiries from New Zealand on scientific matters.

Washington.—The office has had an increased number of New Zealand scientists, who were aided and advised on itineraries, &c. The benefit of having an officer of more permanent status is making itself evident, and could now be improved further by the appointment of a short-term assistant Scientific Liaison Officer. Aid has been given to a number of American scientists visiting New Zealand. There has been an increased demand for reprints of American scientific papers, particularly in the fields of radio, radar, geophysics, engineering, and defence research.

Melbourne.—The Liaison Officer has reported progress on Australian scientific work of particular interest to New Zealand. Work on coal research, including utilization, merits mention, as it should later produce developments which could be very useful to New Zealand.

The British Commonwealth Scientific Official Conference was held this year in Canberra and Melbourne and most member countries included Liaison Officers in their delegations. This occasion provided a very valuable opportunity for the discussion of liaison problems, and improvements in the collection and distribution of scientific information can be expected.

REPORTS OF RESEARCH COMMITTEES OF THE COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BUILDING RESEARCH

Further consideration has been given to the matter of the best method of meeting the research needs of the building and construction industry and furthering the application of developments arising from research overseas. Discussions have been held with officers of the Ministry of Works and with the Government, but no finality has been reached. In the meantime the Department has continued to investigate problems both for Government Departments and for industry.

Particular attention has been given by both Dominion Laboratory and Dominion Physical Laboratory to the testing of pozzolanic materials for their suitability for use in concrete structures. The Engineering Seismology Section of the Dominion Physical Laboratory is investigating the possible effects of earthquakes on buildings. Tests have also been made on the efficiency of domestic fuel-burning appliances. At the Plant Diseases Division further progress has been made in investigations on timber preservation. Research on the physical properties of soil in relation to its stability has been continued by the Soil Mechanics Section of the Soil Bureau. Sites for heavy buildings and earthworks have been tested.

The work of the Dominion Laboratory is reported on pages 18 and 21, that of the Dominion Physical Laboratory on pages 29 and 30, that of the Plant Diseases Division on page 61, and that of the Soil Bureau on page 65.

HOP RESEARCH

Development of hop research has continued on a co-operative basis, with participation by the Cawthron Institute and by the Crop Research and the Plant Diseases Divisions of D.S.I.R. An officer has recently arrived to undertake selection and breeding work at the Hop Research Station, but most of the research programme throughout the year has been maintained by the Cawthron Institute.

Existing hops in the Station garden proved too poor and variable to warrant retention, and poles and wirework have been dismantled preparatory to re-erection at a higher level of wiring. A nursery garden has been established to accommodate the collection of hop varieties and types that has already been assembled.

Three distinct types of the commonly grown Californian variety have been recognized, and some four hundred single cuttings of these types have been set out in the nursery. The young plants have shown marked differences in rate and type of growth. Ninety-five plants raised from seed of Wye varieties have been divided to establish clonal units of four plants each, and these plants have, with one marked exception, done well. A range of selected locally-grown hops has tentatively been typed into nine groups.

Further positive transmissions of virus symptoms from some of the imported cuttings of Wye varieties have been obtained, and all infected material has been destroyed. Various abnormalities in growth of hops have been seen in commercial gardens. An incurling of leaf margins, associated with reduced yield, has been found to be transmissible to young nettle plants under certain conditions but not to healthy hop plants. It may be a virus, but the symptoms differ somewhat from those of known viruses. A defoliation of plants of a Greenbine type was seen in one garden, and soil analyses show that it is associated with a low pH value.

Fertilizer trials have been extended by adding three new areas to the four that are being continued from last season. Results indicate that 5 cwt. standard mixed fertilizer per acre is an inadequate dressing.

In the work on fungous diseases a small garden of ½ acre has been erected at the Hop Research Station and the soil has been heavily inoculated with the black root-rot fungus. Various chemicals are being tested as possible sterilizing agents, and the effect of the chemicals on the growth of hops is being watched at the same time. Extensions of this work are being undertaken in disease-infected commercial gardens and in an isolated test area. A variation in resistance of seedlings of commercial varieties to the black root-rot fungus, *Phytophthora*, has been established. Owing to the close proximity of apple orchards to hop gardens, tests are being made to see whether the apple and hop strains of *Phytophthora* are transmissible from one host plant to the other. Disease surveys in gardens have been maintained.

Chemical studies of hop material have continued, with special attention to boron, magnesium, and nitrogen status. Fifty samples gave an average value of 45·8 p.p.m. boron in the leaves and 29·6 p.p.m. in the cones, with a range of 20·2–70·1 in the leaves and 22·2–30·3 in the cones. In a preliminary examination, twelve samples of hop leaves showed an average magnesia (MgO) content of 1·06 per cent on dry matter, with a range of 0·55–2·36 per cent. The nitrogen content of leaves and cones varied appreciably from garden to garden, and it was found that the leaves on the upper part of the bine, especially lateral leaves at the top, are particularly rich in nitrogen.

MANUFACTURERS' RESEARCH COMMITTEE

Secretary - Executive Officer: Mr. C. P. McEvedy

The Committee has continued to pursue its policy of encouraging and assisting industry to participate in research work and apply scientific techniques to manufacturing and other processes. There is a greater realization among industrialists of the benefits derived from these activities, which are means towards enlarging output, improving quality, and reducing production costs.

Co-operative Research.—The work of the incorporated research associations, which are financed equally by industry and Government, have been reviewed regularly. Excellent progress is being made, and the success of these associations is largely due to the keen interest of industrialists, who themselves assume a major responsibility in directing general policy and the drawing-up of research programmes. The latter are essentially practical, and, since very close relationships are maintained between the associations' scientists and industrialists, the research findings are readily put into practice. The need for special technical education in industry is apparent from the enthusiastic support of both managements and workers to the technical conferences conducted by research associations. Lectures and demonstrations by research personnel and experienced industrialists are fulfilling this need in certain industries by spreading knowledge on the application of scientific developments to practical matters affecting manufacturing processes.

With the growth in membership of the Research Institute of Launderers, Drycleaners, and Dyers of New Zealand (Inc.), subscriptions from industry exceeded the maximum originally fixed for the Government pound-for-pound grant to this research association. A favourable recommendation was made by the Committee for the maximum to be raised, and this was subsequently approved by Cabinet.

Arrangements for inaugurating co-operative research in the bacon-curing industry without the formation of a research association were approved. The work is being undertaken by the Dominion Laboratory, with the assistance of an advisory committee on which the industry is represented. Government and the industry will each bear half of the cost. Proposals for the establishment of a concrete research association have been recommended.

Industrial Servicing.—Branches of the Department have provided advice and assistance on scientific and technological matters to manufacturers who have no research association for their industries. Care is taken to ensure that work within the field of private consultants is not accepted. The facilities of the Dominion Physical Laboratory, the Auckland Industrial Development Laboratories, and the Canterbury College Industrial Development Department have been utilized to provide industry with special services that are not available elsewhere in the country. The work undertaken for industry is reviewed by the Committee, and also by its representatives on the advisory committee of these organizations. Consideration has been given to the policies of the Industrial Development establishments, and also to major projects for groups of manufacturers.

In addition to giving assistance to industrialists on problems, the Industrial Liaison Officers at Auckland, Christchurch, and Dunedin made a survey of the foundry industry to obtain basic data as a preliminary to providing technical assistance for the industry as a whole.

General.—Other matters of wide general interest were dealt with by the Committee. Liaison has been maintained with the New Zealand Manufacturers' Federation, and articles dealing with industrial research were supplied for publication in the Federation's monthly journal.

RADIO RESEARCH COMMITTEE

Following proposals made by the Committee, the Hon. the Minister of Scientific and Industrial Research approved in October recommendations of the Council of Scientific and Industrial Research for the reconstitution of the Committee. The function of the new Committee is to deal mainly with technical policy matters, the consideration of detailed technical activities being delegated to two sub-committees—viz., the Propagation Panel and the Cosmic Relation Panel, dealing with propagation and with the relations between radio and solar and terrestrial phenomena. Both these panels provide a forum for technical discussion, and they report back to the main Committee. The main Committee met twice during the year; the Propagation Panel has held two meetings, and the Cosmic Relations Panel has held eight meetings.

The International Polar Year, 1957-58.—The International Council of Scientific Unions is considering the setting-up of an International Polar Year in 1957–58. The Committee had under consideration the reports of the panels outlining a programme of research projects in radio and allied subjects that would be appropriate for New Zealand to undertake, or to participate in, as part of a world-wide plan. The recommendations of the Committee are to be prepared as a paper for discussion by the Joint Commission on the Ionosphere.

The Tenth General Assembly of the International Scientific Radio Union (U.R.S.I.).—This is to be held in Australia in August 1952. The Committee gave consideration to the contribution that New Zealand should make in the way of technical papers on current research, and to the composition of its New Zealand delegation.

Current Research Activities.—Reports of progress in the activities of the various authorities engaged on research in radio and related subjects were discussed by the Committee, and recommendations were made on the allocation of Government grants for these purposes.

In addition to the programmes of research on radio in the Department being carried out by the Geophysical Observatory and the Dominion Physical Laboratory, the Committee is concerned with the auroral research programme of the Carter Observatory, and the meteor trail project being carried out by Canterbury University College. The Seagrove Radio Research Station of Auckland University College was set up on the Committee's recommendation, and the present research on the direction of arrival of long-distance radio waves is under the general guidance of the Committee.

TOBACCO RESEARCH

Station Director: Mr. R. Thomson

As in previous years, research work has been carried out jointly by the staffs of the Cawthron Institute and the Research Station. The Institute work has included chemical studies on the intake of plant nutrients, chemical analysis of leaf from the field trials and curing experiments at the Station, disease surveys, and investigations into the nature, spread, and control of various diseases. Work at the Research Station has included all phases of the crop in the field, seedling-bed investigations, fertilizer trials, cultural experiments, variety trials, seed-production work, plant-breeding, curing experiments, and control of disease in the field.

Weed Control.—Methyl bromide, applied at the rate of 1 lb. per 100 square feet of seedling bed, controlled weeds as well as did steam. The seed-beds were covered with a plastic sheet, and the gas introduced by means of a special applicator. This method shows great promise if a safe way of handling the fumigant on a field scale can be worked out.

Boron.—Symptoms indicating a deficiency of boron have been observed in several tobacco-growing areas. Five pounds of borax per acre did not affect the yield, but improved the texture and quality of the leaf; 10 lb. of borax per acre caused delayed early growth and a leaf that was very tough to pick.

Control of Laterals.—After tobacco has been topped, the removal by hand of the subsequent lateral growths from the leaf axils requires considerable labour. Striking results were obtained where chemical substances were applied to the topped tobacco in an endeavour to control these laterals. Maleic hydrazide, 1 per cent, sprayed on the upper leaves reduced laterals to negligible proportions. Mineral oil applied to the top of the stem also resulted in marked control.

Plant-breeding.—Breeding for resistance to black root-rot was carried a stage further. Four selections were tested for yield, and three of these equalled the chief commercial variety, Harrison's Special 215. Growth type was good, but the leaf tended to be thin. Some lines still carry a trace of the cigar aroma inherited from the resistant parent, but there appears to be sufficient segregation to eliminate these. New crosses were made bringing in resistance from other sources.

In breeding for resistance to mosaic, some lines of Ambalema origin were continued. Although these appear to be quite resistant, they are not very attractive in leaf type. Breeding to incorporate the resistance of *Nicotiana glutinosa* into local flue-cured varieties is progressing.

Breeding for resistance to verticillium-wilt is handicapped by the fact that no really resistant varieties or species have been discovered. Some lines exhibit a degree of resistance, and these have been used as parents while all available material is being tested out.

Disease Investigations: Black Root-rot.—Chloropicrin, chlorobromopropene, methyl bromide, and calcium cyanamide gave outstanding control of black root-rot in seedling beds with over 90 per cent of clean or very lightly infected plants. Methyl bromide and chloropicrin proved the most satisfactory, the control of black root-rot being almost 100 per cent.

Micronized sulphur at the rate of 4½ oz. per square yard gave considerable control of black root-rot, but DD and TMTD were not effective. Toxic effects on the growth of tobacco seedlings were noted with some chemicals. Root development of the tobacco seedlings was particularly good with chlorobromopropene and methyl bromide treatments.

Chemical Investigations.—Examination of leaf samples with varying amounts of nitrogen, potash, and phosphate in the tobacco fertilizer showed that, with a 4 per cent nitrogen content of the fertilizer, sugars in the tobacco leaf tended to increase with increasing percentage of potash in the fertilizer mixture. With a 3 per cent nitrogen tobacco fertilizer, the highest sugar content of the leaf was associated with a lower percentage (4 per cent) of potash in the fertilizer.

Increases in the intake of potash by tobacco leaves were noted with fertilizers containing both 3 and 4 per cent nitrogen when the potash content of the mixtures was increased. The potash intake was still further increased when phosphate as well as potash in the fertilizer was increased. The addition of magnesium compounds to tobacco fertilizer resulted in an increase of magnesium in leaf samples but no appreciable effect on the sugar content.

REPORTS OF INCORPORATED RESEARCH ASSOCIATIONS

THE DAIRY RESEARCH INSTITUTE (N.Z.)

Director: Professor W. Riddet

The financial year of the Institute ends on 31 July next, when a separate report will be issued by the Institute. The following summary, not included in the Department's 1951 annual report, is for investigations for the year ended 31 July 1951.

Butter.—Studies were made of the effect of variations in operating conditions of commercial equipment for steam distillation of cream on efficiency of taint removal.

Investigations on storage flavour in butter showed that addition of antioxidants, though reducing oxidation according to chemical tests, did not prevent development of storage flavour in butter stored for eight months, but did retard further deterioration after removal of the butter from cold store.

Further experiments on temperature treatment of cream before churning failed to indicate any method for improving body of spring butter.

Additional studies of the properties of New Zealand butterfat provided data on seasonal variations in density, refractive index, and Polenske value.

Buttermilk Powder.—Preliminary trials having indicated that a fibreboard carton with alkathene liner was the most suitable container for buttermilk powder, a trial shipment of cartons was made, with very promising results. Variations in bulk density of buttermilk powder have also been studied in order to determine the optimum carton size.

Cheese.—The search for fresh single strain starter cultures resulted in the discovery of one suitable strain during the year. There are now eight unrelated strains of *Str. cremoris* and one of *Str. lactis.*

In the work on cheese ripening, some interesting observations on the heat stability of bacterial enzymes were made.

It was not possible to produce bitter flavour in cheese by development of too high an acidity. Evidently, although acidity may be a contributing factor, there is some other agent involved in the production of bitter flavour.

During the year, commercial manufacture of cheese containing 52 per cent of fat in the dry matter confirmed the earlier experimental results which indicated that technically the manufacture of good-quality, fat-adjusted cheese presents no special difficulty.

Arrangements were made during the year for the commercial manufacture of blue-vein cheese.

A small shipment of pliofilm-wrapped 1 lb. blocks of Cheddar cheese received favourable comment in England.

Engineering.—The utilization of steam in dairy manufacturing processes was investigated, and methods were devised for recovery of waste heat. A preliminary examination of the amount and causes of heat loss in steam boilers was made. A series of tests was carried out to determine the efficiency of farm milk-coolers and to provide basic data for surface cooler design. The horse-power required in the various stages of butter-churning was measured for several sizes of churn. The performance of equipment used for air-conditioned cheese-curing rooms was investigated, and an allied investigation into the effect of humidity on cheese shrinkage was commenced.

Dairy-cow Nutrition.—Investigations into the influence of plane of nutrition on the yield and composition of milk were continued; this year the effect of a low plane of nutrition during the initial part of the lactation was followed. Some experiments on the palatability of silage were carried out. Other experiments were concerned with the feeding of dried buttermilk of high fat content to calves and with the feeding of calves by tube instead of direct from a bucket.

NEW ZEALAND FERTILISER MANUFACTURERS' RESEARCH ASSOCIATION (INC.)

Director: Dr. M. M. Burns

The Association's laboratories have been in full operation for the past year through additional appointments of professional and office staff.

Research.—Four main projects were continued during the year.

In a pot trial using radioactive phosphorus to compare the uptake by rye-grass of phosphorus from superphosphate and serpentine-superphosphate with that from the same fertilizers in a granulated form, it was shown that granulation slightly increased the efficiency of the fertilizers on the three soil types used. The uptake of phosphorus from fertilizer sources decreased with time, while the uptake from soil sources increased. For the second growth period the relative percentages of the phosphorus taken up were: Waikara clay loam—15 from soil sources, 85 from fertilizer sources; Waiotira silty clay—40 and 60; Weymouth silty clay loam—60 and 40. This supports the observation made in other trials of the importance of soil type on fertilizer responses.

A comprehensive pot trial using radishes as the test crop was conducted on four soil types to test the comparative effectiveness of nineteen regular and experimental phosphate fertilizers applied at equivalent rates of P_2O_5. Outstanding responses were obtained from superphosphate, basic slag, fused calcium-magnesium phosphate, and ground North African phosphate; the reverted phosphates gave very good responses, while ground Nauru rock phosphate and mixtures of superphosphate with high proportions of Nauru rock phosphate gave lower yields than comparable mixtures with ground limestone.

Studies on the compatibility of the sodium salt of 2–4D with phosphate fertilizers have been completed. Chemical analyses of the mixtures and glasshouse and field trials all showed that the incorporation of the hormone with the carrier during the manufacture of the fertilizer led to a 20–25 per cent loss in effectiveness of the hormone for weed control as compared with products made by mixing the hormone, either in the dry state or in a water suspension, with the matured fertilizer.

In the manufacture of normal superphosphate a calculated quantity of about 70 per cent sulphuric acid is used to give full conversion of the insoluble tri-calcium phosphate to the water-soluble mono-calcium phosphate. In order to check whether satisfactory fertilizers could be made by using an equal volume of more dilute acid solutions and thereby increase the output of fertilizer per ton of sulphur, a series of experimental fertilizers was made using sulphuric acid in a range of strengths from the normal 70 per cent down to 20 per cent. Analyses showed the amount of conversion of the rock phosphate was proportional to the sulphuric acid present, and as the products from the weak acid mixtures were very hard to handle and to condition it was concluded that the mixing of ground rock phosphate with normal superphosphate was a more satisfactory procedure to extend the tonnage of phosphate fertilizer than would be the use of weaker sulphuric acid in manufacture.

General.—The issuing of reports and reviews on matters of interest to members was continued and the library service extended.

THE NEW ZEALAND LEATHER AND SHOE RESEARCH ASSOCIATION (INC.)

Director: Mr. F. W. Woodroffe.

The past year has been one of great activity. The membership has again increased.

Leather-manufacture

Oil Tannage.—A further stage on the modification of New Zealand fish oils for the production of chamois leather gave a method for the utilization of vegetable oils in oil tanning. In addition to producing stronger leather, this process also enables white washable gloving leathers to be manufactured without the need for bleaching. It is likely to supersede existing methods, and has therefore been covered by a provisional patent.

Tanning-materials.—Extensive investigations were made into the possibilities of utilizing *Pinus radiata* bark as a source of tannin. Heavy and light leathers were produced in the laboratory, but further development depends upon the economical extraction of tannin from this bark.

One line of research on tanning-materials was based on the utilization of Myrtan, a bark extract of Australian origin. The effects of concentration, acidity, and temperature on the deposition of insolubles was worked out. Attempts were also made to solubilize these precipitates. The effect of mimosa extract on the insolubles from the Myrtan was studied, and the blend that gave the most economic return was determined.

Upper Leathers.—New finishing methods for chrome side leathers that give better cutting area and improved handle to the leather have been introduced.

Shoe Linings.—In correcting the faults in New Zealand sheep-skin leathers used as linings, new methods have been developed which will help in the production of a more suitable leather. The formulation of pigment finishes has received much attention, and firms were assisted to make finishes not otherwise available owing to shipping delays.

Other problems put forward by the tanners that were investigated included studies of sheep-skin degreasing and the recovery of grease from the used liquors, the dyeing of sides and sheep-skins, fat liquoring of calf leathers, the scouring of sole bends, the composition of wax-resin mixtures for use on chrome sole leathers, advice on the hot-pitting of sole leather to give better wearing leather, and investigation of steel knives used in splitting hides.

Hides and Skins

Paints.—The viscosity and effect of age on depilatory paints have been examined. On paint compositions and modifications, comparisons between sodium sulphide and sodium hydrosulphide have been established, and large-scale factory trials using the latter are in progress.

Pickled Pelts.—Important findings have been made in the causes of deterioration in correctly pickled pelts upon arrival overseas. Work is in hand to counter this deterioration, which influences prices of New Zealand pelts in the world market.

The pelt analysis and microscope assessment service has been extended widely and is being used by most of the freezing companies.

Footwear-manufacture

The factory problems handled dealt with the wearing properties of dyed felt soles, where it was found that heavy shades were less satisfactory than pale shades when subject to abrasion; faults arising in the manufacture of patent-leather shoes were investigated and suggestions made to eliminate them; methods of preparing leather for lasting were examined and firms advised on suitable procedures; the failure of sole adhesives was overcome by eliminating the source of contamination, which was due to traces of copper; methods of dyeing shoes when made up were developed; and leathers were tested for suitability in manufacture, and some firms used the service to assist their buying department.

Customers' complaints were mainly brought about by misuse. Damage due to heat, perspiration, battery acid, and the wearing of footwear in wet conditions when new was all too common.

Reports

Quarterly reports to all members have been issued, and full reports of the technical conferences (one of tannery technicians and the other on hide and skin preservation) have been circulated to the groups concerned.

THE NEW ZEALAND POTTERY AND CERAMICS RESEARCH ASSOCIATION (INC.)

Director: Mr. W. Vose

The Association was reorganized upon the extension of its activities into the field of heavy clay products—*i.e.*, bricks, sewer pipes, field drainage tiles, roofing-tiles, quarry tiles, refractories, &c. Work on the whitewares section of the industry is concerned with the manufacture of domestic and hotel wares, electrical porcelain and refractories, sanitary earthenware, and fireclay ware, domestic and chemical stoneware. The extended work of the Association has been hindered by lack of laboratory facilities and staff, but measures in hand should overcome these difficulties shortly.

Finer Wares (Whitewares)

Raw Materials.—The china clays of North Auckland have been extensively sampled, and are shown to be halloysitic. The separation of china clays for use as a filler has been investigated, and this awaits commercial development.

Relatively extensive deposits of very plastic and strong ball clays have been found in Canterbury, Otago, and Southland, and opened up. Except for a slightly dark fired colour they are, as far as can be determined, equal in quality to any in the world.

Large resources of orthoclase felspar have been discovered and development work executed, in collaboration with the Dominion Laboratory, to determine the best methods of reducing the iron oxide content. The percentage has so far been reduced from approximately 0·75 per cent to below 0·20 per cent.

Possible sources of quartzite and flint pebbles for milling have been unfruitfully examined.

Processed Materials and Processes.—The fundamental work upon felspar/clay/quartz compositions has now passed beyond the stage of preparation of materials. A diversion to give immediate information to manufacturers was made.

A study of the relation of the unfired strength to moisture content has shown how production economies can be made in the works. Investigations into the cause of brittleness and weakness of vitrified hollow-ware, the craze resistance of fireclay ware, the thermal expansion of saggars, and the manufacturing difficulties when using halloysitic clays with rod-shaped particles have all contributed to improved processes and products in the works.

Certain reagents have been applied to stabilize casting slips, and mechanical aids to mixing plaster-of-paris have been successful.

Heavy Clay Products

During this first year in the field of heavy clay products the work has been mainly preparational. A survey of the salt-glazed sewer-pipe industry revealed the most urgent problems, some of which have been eliminated already. Improved methods of salting were introduced and economies effected in raw materials. Initial work on drying processes revealed that economies could be made in fuel, factory space, and time. Proposals have been made for new design kilns in order to reduce fuel costs.

Test methods developed in the whitewares work during the past four years have been modified and applied successfully to raw materials used in the manufacture of heavy clay products. These methods are now used for the selection of raw materials and the adjustment of works' mixtures wherever difficulties exist.

General

One final report, sixteen interim reports, and eight information leaflets have been issued.

Regular visits have been made to works, clay deposits, &c.

Two research papers by members of the staff were published in a technical journal.

NEW ZEALAND WOOLLEN MILLS' RESEARCH ASSOCIATION (INC.)

Acting-Director: Dr. L. F. Story

Despite a reduced staff this year, a considerable volume of research and testing work has been carried out.

Effect of Copper on Wool Dyeing.—In continuation of this work, a small number of Corriedale sheep were specially dipped in three concentrations of copper sulphate at Canterbury Agricultural College, Lincoln, in May 1951. Samples of the wool were taken for analysis in June, August, and November. The results indicated that the amount of copper retained by the wool after scouring was roughly proportional to the concentration of the solution used for dipping and it was only slowly reduced by weathering (after allowing for the growth of new wool subsequent to dipping).

The amount of copper present in the scoured wool from the final samples at shearing was sufficient to interfere with the dyeing of copper-sensitive dyes, even from the sheep which had been dipped at the lowest concentration of copper sulphate (0·05 per cent, plus 0·03 per cent in a gammexane dip in January). Also, the greasy wool from nearly all the sheep had a green cast. The results indicate that dipping in copper sulphate solution is undesirable from the point of view of the wool user, except when a low concentration is used not long after dipping. This, however, would probably have little effect against mycotic dermatitis.

Since 0·05 per cent copper sulphate (plus 0·03 per cent in January) was enough to leave appreciable amounts of copper on the wool, the effect of 0·03 per cent as used in gammexane dips as a bacteriostat, has been investigated. The copper contents of most of a range of samples tested were negligible, but a few samples, notably of early-shorn wool and from Lincoln, contained larger amounts of copper, which were just sufficient to affect a sensitive dye. It is not considered that the use of 0·03 per cent copper sulphate in the gammexane dip is harmful in general, though it might be better to avoid late dipping of early-shorn sheep.

Shrinkage of Hospital Blankets.—In hospital use, blankets are laundered in rotary machines and consequently are likely to shrink more rapidly than in domestic use. It therefore seems desirable that the blankets supplied should have as low a tendency to shrink as possible. Samples of blankets from each of the eleven mills making them have been examined, and their shrinkages were found to range from 8 per cent to 26 per cent in a standard test, while samples of English hospital blanket shrank about 14 per cent. The shrinkage appeared to be related to the fineness of wool used, and to the structure.

Army Socks.—In view of a complaint from the Army that the socks supplied by various mills differed in wearing qualities, a detailed comparison of the structures and abrasion resistances of socks from six mills has been made. A considerable difference in resistance to abrasion was found in the samples tested, and this appeared to be related mainly to the gauge of machine (number of needles) used.

Nylon Splicing in Socks.—Several tests of the abrasion resistance of nylon-spliced socks have been made. A considerable improvement over worsted splicing is obtained by using nylon in alternate courses, but an increased effect results from using nylon in every course. In this case a skeleton of nylon threads remains long after all the wool has been worn away, so that the formation of a hole is delayed for a considerable time.

Worsted Oils.—Mill trials have been carried out with two new oils both based on mineral oil with the addition of nonionic assistants. These oils were found to minimize the production of fly in drawing owing to their antistatic

behaviour and to be readily scourable by soap and bicarbonate or with synthetic detergents. One of the oils is, in fact, so readily scourable that it is likely to give trouble in top-dyeing if the full amount is applied before dyeing, owing to some of the oil being removed and fouling the dyeing-machine.

Combing.—Various small alterations were made to a comb to find what effect was produced on the ratio of top to noil and the mean fibre length of the resulting top.

Drawing.—The drafts in a set of drawing were altered to reduce the weight of the final roving and so to reduce the spinning draft necessary. This resulted in better spinning and a slightly stronger yarn.

Noise.—A comparison was made of the efficiencies of several noise-absorbing wall linings for use in weaving-sheds and other parts of mills.

Early-shorn Wool.—A comparative processing trial of two lots of wool, one early shorn and the other late shorn, has been commenced. The early-shorn lot was somewhat shorter than the other, but on inquiry it was found that this was probably due to a shorter period of growth between successive shearings.

RESEARCH INSTITUTE OF LAUNDERERS, DRYCLEANERS, AND DYERS OF NEW ZEALAND (INC.)

Research Officer: Mr. P. Carlyon Coates

Even though staff, equipment, and facilities are limited by very restricted space in the present temporary laboratory, the activities of the Institute have expanded. Membership has grown steadily.

Investigations.—There was a threefold increase in the number of investigations into problems on fabric damage and stain removal. Hospital Boards particularly are making full use of this service, which has proved valuable in overcoming difficulties, and enabling preventive measures to be taken against future losses. Two cases, both in different laundries, dealt with fires which broke out among clothing upon removal from tumbling-machines.

The serviceability of a number of textile materials was investigated to determine their suitability for laundering and cleaning.

Raw Materials.—In addition to analysing materials used in laundering and drycleaning, a comprehensive survey was made of soaps available to the laundry industry. An informative report on the results of the survey was distributed to members in order to assist in selecting the most satisfactory and economical form of soap for particular purposes—*e.g.,* chips, powder, bars, &c. A solvent testing service was started towards the end of the year, and this will be extended. Information was supplied to Government Departments in connection with importation of materials, which enable improved processes to be used in the drycleaning industry.

Technical Training.—The first course of instruction in washhouse methods was attended by laundry managers, who were given intensive theoretical and practical training for one week. It is intended to arrange further courses whenever possible.

Visits.—Visits have been made to members' plants to give assistance in dealing with problems and improving processes.

Annual Convention.—A large number of people engaged in the industry attended the Fourth Annual Convention, at which technical lectures and demonstrations were given. The proceedings were published in book form and distributed to members for study and reference.

Information.—Bulletins dealing with scientific and technical developments in the industry, both overseas and locally, were distributed to members weekly.

CAWTHRON INSTITUTE

Director: Sir Theodore Rigg

Aided by grants from the Department of Scientific and Industrial Research, work has been carried out on a wide range of problems of the tobacco, hop, fruit, and tomato industries of the Nelson district. Other work of more general application has included entomological, soil, and plant nutrition studies. In tobacco, hop, and entomological investigations the Institute collaborates with the Department of Scientific and Industrial Research, and this work is reported under "Tobacco Research," "Hop Research," and "Entomological Research Station."

SOIL INVESTIGATIONS

"Moutere Gravel" Soils.—In co-operation with the Departments of Agriculture and Scientific and Industrial Research and the New Zealand Forest Service, surveys of soils, topography, and vegetation of some 300,000 acres of "Moutere gravel" land were completed. A technical bulletin—covering the surveys, reviews of agriculture, horticulture, and forestry and a report on land utilization—was prepared, and published under the auspices of the Nelson Catchment Board.

Soil Map of the South Island.—In co-operation with the Soil Bureau, further surveys were made of soils in Takaka and Collingwood counties with a view to completion of the soil map of the South Island on a scale of 4 miles to 1 in. Chemical work on soil samples from Takaka and Collingwood counties is being carried out by the Institute.

Soil Map of the Hop Research Station.—A detailed soil map of the Station land was made to facilitate planning and interpretation of experiments.

Estimation of Molybdenum in Nelson Soils.—Methods of estimating molybdenum were further examined. Two soils of rather wide distribution in Waimea County were found to be low in molybdenum.

Soil Analyses.—Many soil samples were analysed to elucidate crop problems in the Nelson district.

PLANT NUTRITION INVESTIGATIONS

Boron Deficiency in Hops.—Owing to seasonal conditions, only one treatment—a combined magnesite borax application—gave a definite effect on hop growth. Analytical data from 1950–51 samplings showed that ½ oz. borax per hill increased the boron content of hop leaves from the upper portion of the plants from a range of 38 to 70 p.p.m. in the controls to a range of 192 to 531 p.p.m. in the treated plants. In the cones the boron figures were 25 to 30 p.p.m. for untreated plants and 43 to 67 p.p.m. boron for treated plants. The recommended dressing of ½ oz. borax per hill should not be exceeded and the borax should be spread over a circle of not less than 18 in. diameter; otherwise the plants are liable to injury.

Magnesium Deficiency in Hops.—Symptoms of magnesium deficiency in several hop gardens were no doubt caused by the wet spring and a leaching of available magnesium from soils rather poorly supplied with this mineral. Magnesite gave some benefit, but not complete control.

Distribution of Dry Matter in Hop Plants.—The dry matter in various parts of the plant, expressed as percentage of the total dry matter produced, was as follows: cones, 46·6; bines, 12·4; leaves on bines, 7·5; laterals, 18·2; and leaves on laterals, 15·3. The average dry-matter contents of cones and whole plants were 22·4 and 24·5 per cent respectively. On the basis of 1,200 plants per acre, the total dry-matter production above ground-level was 3·9 tons. Other investigations dealt with the penetration of borax in soil and its rate of leaching.

FRUIT RESEARCH

Boron Deficiency of Raspberries.—Owing to frequent showers throughout the spring and early summer, the past season did not favour the development of boron deficiency symptoms. Plots treated with ground dolomite to control magnesium deficiency, however, showed symptoms of boron deficiency, probably because of reduced solubility of boron consequent on the high pH induced by the dolomite. A divided application of borax satisfactorily controlled boron deficiency in raspberries on a granite soil at Orinoco. In the previous season a single large application was not effectual.

Magnesium Deficiency of Apples.—Ground dolomite continued to give better control of magnesium deficiency of apples than either magnesite or magnesium sulphate. It also improved the growth of young trees where replanting was necessary.

Zinc and Copper Deficiencies.—Zinc sprays were continued without effect on certain apple blocks at Tasman, confirming previous tests. Soil examinations showed that certain orchards had been over-limed, and it is possible that this may induce deficiencies, such as of zinc, in seasons of low rainfall. Spray trials on apples at Mariri still gave no indication that copper was nutritionally important for this crop on Moutere soils. Raspberries at Rakau, however, benefited from copper sprays or soil applications of copper sulphate.

Disease Investigations.—Tests are being carried out with species of *Phytophthora* affecting hops (black root-rot) and tobacco (canker) to ascertain whether apple stocks and scions are susceptible to them.

TOMATO INVESTIGATIONS

Control of Tomato Soil Diseases.—Steam and chemical disinfection of glasshouse soil were again studied in respect of yield and quality of crop. The untreated plot showed a further deterioration; steam, chloropicrin, or chloropicrin with D-D gave satisfactory results, but D-D by itself was not so effective. Chlorobromopropene showed considerable promise, but wilt diseases were noticed during the latter part of the season.

Compost and Organic Fertilizers for Glasshouse Soil.—Compost at 15 tons per acre with the standard mixture of fertilizers again gave a higher yield of tomatoes than without compost. Cocoa-bean husks at 10 tons per acre, on unsterilized soil receiving standard fertilizer mixture, gave a better yield than the plot without husks.

Additional Potash and Nitrogen on Quality of Tomatoes.—This gave considerable improvement in the quality of tomatoes from plots with both heavy and moderate rates of watering. Yield was adversely affected, however, by the higher rates of potash and nitrogen top-dressings.

"Cloud" in Glasshouse Tomatoes.—Heavy watering was associated with vigorous growth and heavy yield of fruit with a low content of dry matter, and with a considerable amount of "cloud." Relatively large top-dressings of mineral fertilizers containing superphosphate, muriate of potash, and sulphate of ammonia greatly reduced or eliminated "cloud" and increased greatly the dry-matter content of the fruit. Shading of the plants or heavy pruning of the foliage both reduced the dry-matter content of the fruit and promoted "cloud."

UNIVERSITY COLLEGES

Grants were made by the Department to Canterbury and Massey Agricultural Colleges and to Canterbury University College.

CANTERBURY AGRICULTURAL COLLEGE

ANIMAL HUSBANDRY

Professor I. E. Coop

Corriedale Progeny Test.—The fourth Corriedale progeny test, which commenced in 1950, was completed in November 1951, and a further test was commenced in March 1951. Ten rams were accepted for the 1950–51 test, and, of these, one, No. 7, proved to be of outstanding breeding quality. The results from this ram were comparable with the results obtained from the outstanding merit sire found in the first progeny test. In both cases the progeny were 20 per cent better than the progeny of all the rams for breed type, carcass, and fleece.

Flock progeny testing has been continued in the Rinaultrie (Romney Marsh) and Eskdale (Corriedale) stud flocks.

Analyses of the nutritive value of individual species collected from an enclosed area of tussock grassland near Lake Coleridge at various times of the season are being made.

ENTOMOLOGY

Mr. L. Morrison

A study of the Factors Affecting the Pollination and Seed Setting of Red Clover.—The main objectives of this study are to find the relative efficiency of hive bees and bumble bees as pollinators of red clover; to test the effect of different manurial treatments on time of flowering, height to which the nectar rises, and the length of the corolla tube; and to find if honey bees can be "conditioned" to encourage them to visit red-clover flowers.

FARM MACHINERY

Mr. A. W. Riddolls

Mechanical Ditch Cleaning.—The prototype machine has now been brought to a stage where it is ready for commercial production, and negotiations to this end are now in train. Trials have shown that the prototype is capable of cleaning typical farm stock water-races and small ditches in Canterbury at an average rate of 1 chain per minute.

Small Seeds Harvesting.—Good progress has been made on design and construction of the experimental threshing-machine, but it could not be completed in time for full-scale experimental work this harvest.

FIELD HUSBANDRY

Associate Professor J. W. Calder and Mr. C. E. Iversen

Subterranean Clover Grazing Trial at Ashley Dene.—The season was favourable to growth up to November 1951. Thereafter dry conditions resulted in a rapid drying off of the herbage. The production from grass and clover mixtures reached 2,718 lb. of dry matter per acre, compared with 3,799 lb. in the past season. A mixture of lucerne *Phalaris tuberosa*, and subterranean clover produced the highest yield of 4,037 lb. of dry matter per acre.

MICROBIOLOGY

Dr. I. D. Blair

Plant Disease Survey.—The most severe effects of rye-grass blind-seed disease (*Phialea temulenta*) in field crops have been avoided in a second season by planning the field sowings to secure a measure of isolation from other sources of disease infection. New records in Canterbury include *Didymella lycopersici* (tomato stem canker) and *Heteropatella valtellinensis* (a carnation leaf spot), both causing severe diseases in commercial crops.

Plant Pathology.—Five years' work on aspects of seed disinfection of peas, including interaction of treatments with sowing date, has been assembled as a paper for publication. The identification of *Erysiphe graminis* physiological races (wheat powdery mildew) is being continued.

Soil Microbiology.—Laboratory experiments are proceeding on aspects of the physiology of the fungus *Cercosporella herpotrichoides* (wheat eye-spot). In experiments on subterranean clover nitrogen-fixing bacteria, a number of physiological races of the *Rhizobium* have been identified.

LIME

Mr. B. L. Elphick

A study is in progress on the rate of reaction, downward movement, and leaching of lime from the soil under Canterbury conditions following the application of ground limestone to pastures on various soil types on the college lands. The objectives are (1) to test the effects of hardness and fineness of grinding on the solubility of limestone in the topdressed sward; (2) to study the effects of rate and frequency of dressing on the retention and leaching loss of lime on different soil types. Information is sought on the effects of lime status and soil type on the economy of lime use. It is hoped to measure leaching losses of calcium by keeping a chemical balance-sheet.

WOOL

Dr. A. E. Henderson

Wool Survey.—A preliminary summary of data accumulated during ten years' field operation has been completed. Analysis is proceeding, and should soon be completed. Field-work has ceased.

CANTERBURY COLLEGE INDUSTRIAL DEVELOPMENT DEPARTMENT

Director: Mr. T. R. Pollard

During this period the industrial work of the department considerably increased. South Island, and more especially Canterbury, industry is making increased use of the service available. The strike and power shortage gave rise to a certain amount of lost time and extra expense, and the absence of the Director overseas threw extra work on the small engineering staff. Lack of space is still the most serious item, in that a great deal of staff time is wasted in continually assembling and disassembling test equipment.

Projects.—The number of projects handled for industry over this period were 273, and for Government Departments 103.

The tentering-machine for the Disabled Servicemen's Association has been completed and put into successful operation. Tests were made and report issued on X-ray voltage stability for the North Canterbury Hospital Board. The development of an automatic coding equipment for a fire-alarm company was undertaken and completed.

Development of an electronic stimulator for the non-convulsive treatment of mental patients was undertaken, and the machine is in successful operation by Dr. Mirams at the Christchurch Mental Hospital. It shows a considerable advantage over the older type of machine.

An electronic alarm system to give a visual signal to allow a deaf person to " see " the crying of a child was made. An electronic stimulator and recorder for Canberra University has been designed in collaboration with the Otago Medical School and the Electronics Department of Canterbury College.

Considerable progress has been made in the non-destructive testing of materials by using the magnetic particle method and the supersonic method. Both these methods are useful in locating flaws in welding and fatigue cracks in stressed parts. It is anticipated that before the end of 1952 it will be possible to give a regular service in this field.

A number of problems have been handled in co-operation with the Mechanical Engineering Department of the School of Engineering and with the Industrial Chemistry Department of Canterbury College.

MASSEY AGRICULTURAL COLLEGE

ANIMAL NUTRITION PROJECTS

Dr. C. R. Barnicoat *et al.*

Milk Yield of Romney Ewes.—The effects of low plane of grazing (overstocking) on milk yield and of early weaning on lamb growth rate were studied. Milking abilities of five-year-old Romneys were compared with those of half and three-quarter Romney x Cheviot ewes.

Wear in Sheep's Teeth.—A survey (part-time) made over the last seven years was completed. The information relates mainly to aspects classifiable under (1) anatomical, (2) type of country, and (3) management headings. A start has recently been made on biochemical (nutritional) aspects of the problem.

ROMNEY X CHEVIOT CROSSBRED SHEEP EXPERIMENT

Professor G. S. Peren, Mr. W. R. R. Hewitt, and Mr. T. O. Phillips

The results of the Cheviot Half-bred *v.* Romney trial, which has been carried out on the college's hill-country property near Aokautere since 1944, have been published in the form of a college bulletin and widely circulated.

SHEEP-BREEDING EXPERIMENT

Professor A. L. Rae, Mr. R. A. Barton, *et al.*

In the collection of data on fleece and carcass production in the experimental flock, attention is now being directed toward discovering to what extent interactions between hereditary and environment affect productive characters. In addition, a study is being made of genetic antagonisms between characters that may reduce the effectiveness of selection within the Romney breed.

PLANT PROPAGATION

Dr. J. S. Yeates

Work has been continued on the tip grafting of rhododendrons. The Royal Horticultural Society has accepted a paper on the subject for publication, and has asked for a paper on the same means of propagation in *Camellia reticulata*. The responses of Daphne cuttings to different hormones is being studied from other angles, including sterile tissue culture.

NEMATODE PARASITISM IN SHEEP

Dr. J. H. Tetley

Studies were continued on the seasonal incidence of round-worm parasitism in sheep. A new line of work was begun; the first season's results indicate that lambs fed on a pure stand of high glucoside white clover had lower parasitism than those fed on red clover, and red-clover-fed lambs fewer than cocksfoot-fed lambs. It would appear that gulcoside content alone did not explain the result.

MANURIAL TRIAL UNDER ROTATIONAL GRAZING

Professor A. W. Hudson and Mr. C. V. Fife

This experiment compares the effects of superphosphate (= super) at two rates per acre, with basic slag, super plus lime, and super plus lime plus potash on the soil, pasture, and stock. The experiment, now in its thirteenth year, is probably the oldest grazing experiment in New Zealand. Limed plots continue to give best carrying.

PAMPAS RESEARCH

Mr. W. A. Jacques

Routine treatment was carried on without records being taken. Fertilizer and ground cover trials are to be laid down this autumn. Weights of the plots have been taken to allow for the test of co-variance to be made.

FARM DRAINAGE

Professor A. W. Hudson and Mr. H. G. Hopewell

This covers both mole and tile drainage.

Records of outflows from experiments continue to be kept. New investigations include trials of shallow mole drains; measurement of the effect of drainage on carrying capacity on clay soils; trials in conjunction with the Department of Agriculture to determine the durability of concrete tiles and the strength of clay tiles. Investigations are projected to determine the damage which tile drains may suffer as a result of the passage of heavy traffic, such as modern lime-distributors, over them.

WOOL ZOOLOGY

Dr. F. W. Dry

Mendelian breeding of strongly medullated fleeces of two different genetic types has become simple. On this foundation more advanced studies of inheritance are in progress, and research on the relation of medullation to carcass characterization and thrift. The experimental stocks are thus providing material for tackling a major live-stock breeding problem—namely, genetic correlation. Fibres classified on our technique are being used at Leeds under Professor Speakman in wool chemistry research related to manufacturing properties.

COMMONWEALTH AGRICULTURAL BUREAUX

The Commonwealth Agricultural Bureaux consist of ten Bureaux, three Institutes, and a Headquarters, all but one located in the United Kingdom, which prepare and publish abstracts on the scientific and technical literature of the world in the fields of agriculture and forestry. This service enables research workers and others in New Zealand to keep in touch with details of work being carried out in these subjects in overseas countries.

The Governments of the Commonwealth contribute to the support of the Bureaux, and the funds are augmented by the world-wide sale of their publications. The C.A.B. is represented in New Zealand by a Liaison Officer, who is a member of the Department, and by thirteen specialist Official Correspondents, in this and other Departments, each representing a Bureau or Institute.

Dr. E. Marsden, Scientific Adviser, London, is a member of the Executive Council.

By Authority: R. E. Owen, Government Printer, Wellington.—1952.

Price 1s. 9d.]